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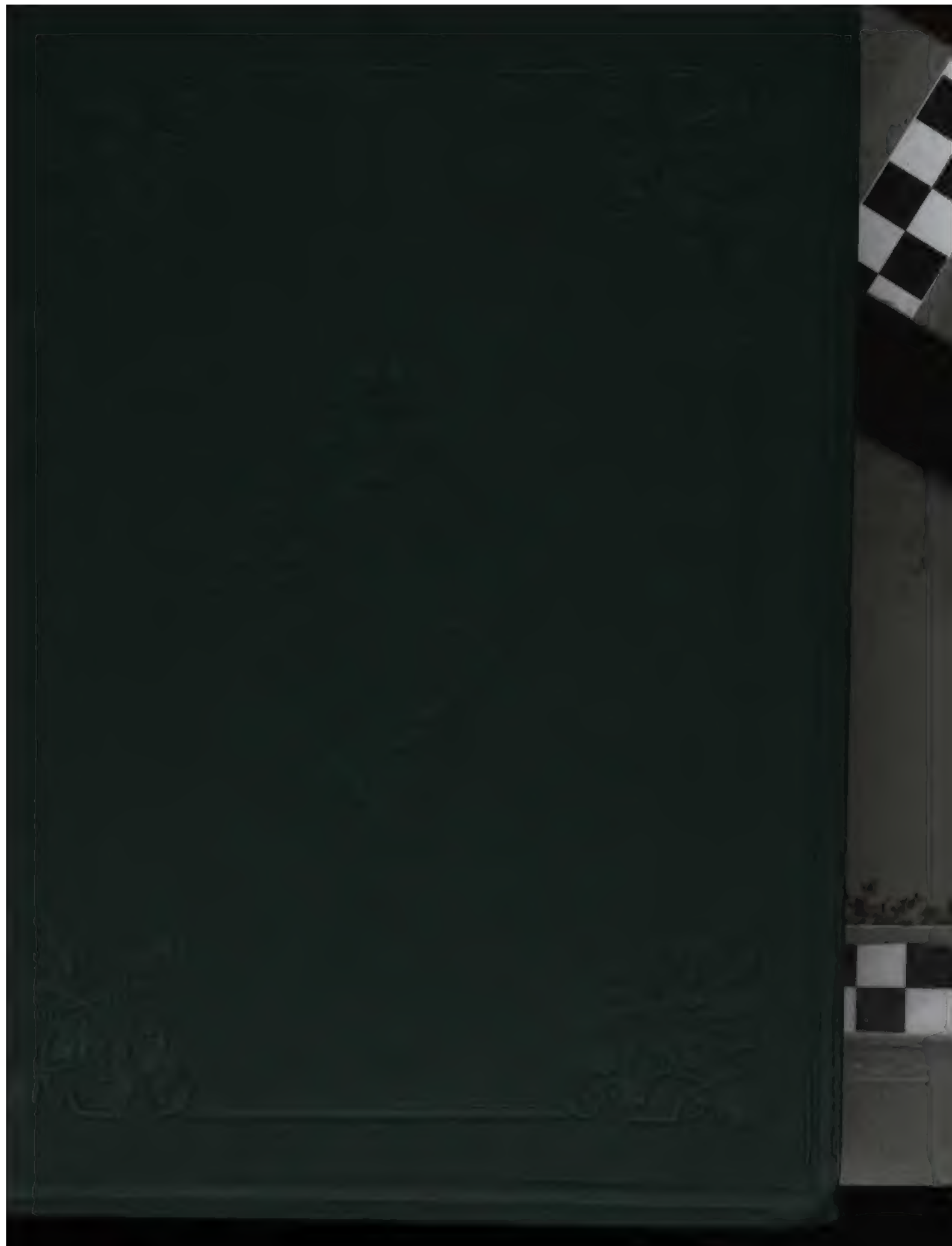
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*J. C. Tanner*  
1903  
THE  
GEOLOGY AND PALÆONTOLOGY

OF

QUEENSLAND

AND

NEW GUINEA,

WITH SIXTY-EIGHT PLATES AND A GEOLOGICAL MAP OF QUEENSLAND.

BY

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PUBLISHED UNDER THE AUTHORITY OF THE HON. W. O. HODGKINSON, M.L.A., F.R.G.S.,  
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**Dedicated**

**TO THE MEMORY OF THREE WORTHY PIONEERS IN AUSTRALIAN GEOLOGY,**

**SAMUEL STUTCHBURY,**

**WILLIAM BRANWHITE CLARKE,**

**AND**

**RICHARD DAINTREE.**





## PREFACE.

### GEOLOGY.

THE material for the present Work has been accumulating ever since my arrival in the Colony in 1877. It was, however, only in the year 1881 that the idea occurred to Mr. R. Etheridge, Junr., and myself to combine our labours, so that in laying a foundation for future work Stratigraphy and Palæontology should go hand in hand.\* The necessity for a Handbook explanatory of the Exhibits at the Colonial and Indian Exhibition of 1886 brought forth a hastily-written *résumé* of the conclusions arrived at up to that date, which must be understood to be superseded by the present volumes.

But for the encouragement and assistance rendered to me by my Colleague, I question if I should ever have finished my portion of the congenial task. I do not, of course, refer to my work as finished in the sense that nothing need be added to it by myself or others, but it was necessary, at some time or other, to gather together the scattered material which had accumulated, and to regard the collection as a record of the Geology of Queensland up to date. My labours in the field, occupying, as they did, often the greater part of the year, and necessary office and laboratory duties at headquarters, retarded the progress of the work from year to year. Another cause of delay, and that the most serious, was the difficulty of what is called in legal phraseology "closing the record," as fresh material poured in from day to day, and called for the reconsideration of many of the results already arrived at. My lifetime, just as well as a portion of it, might have been spent on the work if this difficulty had not been resolutely looked in the face.

To numerous Writers and many Personal Friends my obligations for assistance rendered are deep and heartfelt. Their services will be found referred to throughout the Work.

The highest function of a Geological Survey is to lay a basis for future scientific observations by accurately mapping the relations of the various formations met with in a given district. I cannot say that this beau ideal has been reached in Queensland. In every country, and especially in every new country, it becomes necessary in the first place to give attention to districts remarkable for the presence or prospects of mineral deposits. The "Reports" of the Geological Surveys of Queensland form, for the most part, a series of such observations, and include as much stratigraphical work as has been found possible under the circumstances. By piecing together these isolated surveys, and adding to them such information as is procurable from outside

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\* We began by publishing conjointly a "Catalogue of Works, Papers, Reports, and Maps on the Geology, Palæontology, Mineralogy, Mining and Metallurgy, &c., of the Australian Continent and Tasmania." 8vo. London: Stanford: 1881. The Catalogue was republished in 1882 by the New South Wales Government.

sources, a Geological Map of the Colony has been compiled with some approach to accuracy, although in many cases all that could be ascertained was that a certain deposit occupied a given position, the boundaries having to be guessed at from the compiler's knowledge, whether at first or second hand, of the topography of the district in question.

The first Geological Map of the Colony was a Sketch on the scale of about a hundred miles to the inch issued with the late Mr. Richard Daintree's Paper "On the Geology of Queensland," read before the Geological Society of London on 24th April, 1872. The next was a hand-coloured Map on the scale of sixteen miles to an inch, prepared by me for the Colonial and Indian Exhibition of 1886, and which was published in the same year under the authority of the Department of Works and Mines on the reduced scale of thirty-two miles to an inch. The third is that on the scale of sixteen miles to an inch, issued with the present Work.

As this Work is, to a large extent, based on official Geological Surveys, it may be well in this place to give a brief account of the *personnel* and a list of the publications of these Surveys.

Prior to the separation of Queensland from New South Wales, the late Rev. W. B. Clarke, F.R.S., &c., was employed by the Government of New South Wales in the Northern District of that Colony, as it now stands, and extended his observations into the Darling Downs and Moreton Bay Districts, which are now included in Queensland. In a letter, dated 14th October, 1853, addressed to the Colonial Secretary of New South Wales,\* Mr. Clarke described the Condamine Basin and the Creeks of the Darling Downs, with their included Marsupial and other remains, the trappean rocks of the Upper Condamine, the auriferous alluvial deposits of Lord John's Swamp, the slaty rocks of Pikedale, and the portion of the Coalfield on the Condamine Waters.

Mr. Samuel Stutchbury, F.G.S., Curator of the Bristol Philosophical Institution, on the recommendation of Sir Henry De la Peche, was appointed Geologist for the Colony of New South Wales on 27th December, 1850. Sir Henry described Mr. Stutchbury as "highly qualified for the service, and well instructed in our mode of work on the Geological Survey of Great Britain." Mr. Stutchbury held the appointment till the end of 1855, and from October, 1853, was employed chiefly in the Southern portions of what is now Queensland, having extended his observations northward to Keppel Bay, when the state of his health obliged him to resign and return to England.

Mr. Stutchbury's Reports were issued tri-monthly, and published as Legislative Assembly Papers. The first to deal with a portion of Queensland is the Tenth, of which I have never seen a copy. It appears to have been descriptive of "The Eastern Ranges opposite the Berrigal Station."

The Eleventh Report, dated from the Darling Downs, 1st October, 1853, deals with the same neighbourhood, and portions of the Dividing Range between Queensland and New South Wales, and is accompanied by a Geological Map of the district between the Nandawar Range in New South Wales and Talgai in Queensland.

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\* Legislative Assembly Papers, N. S. Wales, fop., 1853.

The Twelfth Report is dated from South Brisbane, 1st January, 1854, and describes the basalts of the Condamine River and its tributaries, and the portion of the Ipswich Coal Field extending from the Basaltic Range of Toowoomba to Brisbane, and is accompanied by a Geological Map of the district between Dalby and the mouth of the Brisbane River.

The Thirteenth Report is dated from the Pine River, 20th May, 1854, and is descriptive of the Ipswich Coal Measures. It is accompanied by a Geological Map of the District from Ipswich down the Brisbane River and northward to Caloundra Point, and another showing the Coal crops of the Rivers Brisbane and Bremer.

The Fourteenth Report dates from Durundur, 1st August, 1854, and describes the Country from the North Pine River, *via* Caboolture, to Durundur. In this Report Mr. Stutchbury sums up his observations on the portion of the Ipswich Coal Field visited by him, and it is evident that he had not grasped the idea that it was separable from the Permo-Carboniferous Coal Measures of New South Wales proper.

The Fifteenth Report, dated from Auckland Creek, near Gladstone, in January, 1855, deals with the Country from Colinton to Gladstone, and is accompanied by a Geological Map extending from the junction of the Brisbane and Stanley Rivers to the mouth of the Boyne River.

Mr. Stutchbury's Sixteenth and last Report is dated from Sydney, 20th November, 1855, and describes part of the Coast District between the Boyne and Fitzroy Rivers, and is accompanied by a Geological Map.

Mr. Stutchbury's Reports display keen powers of observation, and are not known so well as they ought to be. They are, however, extremely difficult to obtain.

In 1868 Mr. D'Oyley H. Aplin was appointed Geologist for the Southern District of the new Colony of Queensland, and in the same year Mr. Richard Daintree, C.M.G., both formerly of the Geological Survey of Victoria, was appointed Geologist for the Northern District. Mr. Aplin held the appointment till the end of 1869, and Mr. Daintree to the end of 1871.

Mr. Aplin's Reports are seven in number, all in fcp., the first two, or perhaps three, published as Legislative Council, and the remainder as Legislative Assembly Papers.

His First Report, "On the Geological and Mining Features of the Gympie Gold Field," is dated 2nd July, 1868.

The Second is a Report, dated 10th August, 1868, which I have never been able to obtain.

The Third, dated 23rd October, 1868, is a "Report of the Government Geologist of the Southern District," descriptive of an examination (for Gold) of the Country on the east side of the D'Aguilar Range, and of the Neurum-Neurum and Delaney's Creeks and adjacent Country, as far as the junction of the former with the Stanley River.

The Fourth, dated 16th January, 1869, is a "Concluding Report of the Government Geologist for the Southern Division, on the examination for Gold of the Country south of the Bunya Bunya Range, between the River Brisbane and the Coast, including some Observations on the Gold Deposits at Jimna and Gooroomjam."

The Fifth "Progress Report of the Government Geologist for South Queensland" is dated 31st March, 1869, and refers to the Talgai Gold Field.

The Sixth, a "Report on the Auriferous Country of the Upper Condamine, embracing the Diggings at Talgai, Thane's Creek, Canal Creek, and Lucky Valley," is dated 28th July, 1869, and is accompanied by a Geological Map.

The Seventh and last Report, dated 17th January, 1870, is "On the Geological and Mineral Features of a part of the Southern and Northern Portions of the Burnett District."

Mr. Daintree made six Reports (all published in fcp. as Legislative Assembly Papers), as follows:—

- (1.) On the Cape River Diggings, and the latest Mineral Discoveries in Northern Queensland, October, 1868.
- (2.) On Gold Discoveries in the Gilbert Ranges (with Map), dated 7th April, 1868.
- (3.) Progress Report on a Portion of the Rockhampton Mining District, with a Geological Map of Mount Wheeler.
- (4.) General Report on the Northern District, 2nd February, 1870.
- (5.) On the Ravenswood, Mount Wyatt, and Cape River Gold Fields, &c., dated 29th August, 1870.
- (6.) Geology of Queensland as represented at London Exhibition, 1871, 3rd November, 1871.

Mr. Daintree went to London in charge of the Queensland Mineral Exhibits at the 1871 Exhibition, and remained there as Agent-General for the Colony. In addition to the above Reports, Mr. Daintree wrote an important Paper, "Notes on the Geology of Queensland," in the Quarterly Journal of the Geological Society of London, for 1872. To this Paper there were appended Descriptions of the Fossils, by Mr. Robert Etheridge, F.R.S., F.G.S., Palæontologist to the Geological Survey of Great Britain, and Mr. W. Carruthers, F.R.S., F.G.S., Keeper of the Botanical Department in the British Museum. The Geological Map, which has already been referred to, was issued with this Paper, and was afterwards reproduced in colours by the Queensland Government.

A Map of Queensland, "Showing Mineral Areas," by Mr. Daintree, was issued with a "Handbook for the Use of Intending Immigrants" (n.d.), and again with a smaller "Handbook for Immigrants to Queensland," London, 1875. Both Handbooks were compiled by Mr. Daintree. The first-mentioned contains numerous photographs by him, which are evidently reductions of the large coloured photographs, mostly taken with a view to the illustration of geological structure, which adorned the Queensland Court of the 1871 Exhibition.



Mr. (now the Hon.) A. C. Gregory, C.M.G., F.R.G.S., formerly Surveyor-General, whose explorations had already added so much to our knowledge of the interior of Australia, held the appointment of Geologist for the Southern District from 1875 to 1879. During this period he issued the following Reports (all in fcp.) :—

- (1.) On the Geology of Part of the Districts of Wide Bay and Burnett, 19th August, 1875. (Legislative Assembly Paper.)
- (2.) On the Coal Deposits of the West Moreton and Darling Downs Districts, 8th March, 1876. (Council and Assembly Paper.)
- (3.) On the Burrum Coal Mines, 9th November, 1878. (By Authority.)
- (4.) Geological Features of the South-Eastern Districts of the Colony of Queensland, 15th September, 1879. (Legislative Assembly Paper.) With reference to this Report, a "Geological Map of Moreton and Darling Downs," on the scale of eight miles to an inch, was published by the Government in 1879.
- (5.) On the Search for Coal between Dalby and Roma, 10th September, 1879. (Legislative Assembly Paper.)

In addition to the above, Mr. Gregory, when Surveyor-General, made a Report "On the Mineral Discoveries on the Head of the Sovern River and its Tributaries," dated 29th April, 1872. (Council and Assembly Paper.)

After an experience of ten years on the Geological Survey of Scotland, I was appointed Geologist for Northern Queensland on 29th March, 1876, and arrived in the Colony in 1877. On Mr. Gregory's retirement the Geological Survey of the whole Colony was placed under my charge. In 1883, Mr. William H. Rands, A.R.S.M., F.G.S., and on 6th December, 1888, Mr. Andrew Gibb Maitland, F.G.S., who had been trained in England for the Geological Survey, were appointed Assistant Geologists. These gentlemen and myself at present form the Field Staff of the Geological Survey. We have published the following Reports :—

- (1.) On the Geology and Mineral Resources of the District between Charters Towers Gold Field and the Coast, 14th May, 1878 (1879). R.L.J.\* Fcp. (C. A. Paper). With two Geological Maps.
- (2.) Geological Features of Part of the Coast Range between the Dalrymple and Charters Towers Roads, 7th June, 1878 (1879). R.L.J. Fcp. (C. A. Paper).
- (3.) Preliminary Report on the Bowen River Coal Field, 18th July, 1878 (1879). R.L.J. Fcp. (C. A. Paper). With a Geological Sketch Map.
- (4.) On the Bowen River Coal Field, 23rd November, 1878 (1879). R.L.J. Fcp. (C. A. Paper). With a Geological Sketch Map.
- (5.) On the Normanby and Marengo Gold Fields, 15th May, 1879. R.L.J. Fcp. (C. A. Paper). With two Geological Maps.
- (6.) On the Progress of the Search for Coal in the Cook District, 19th June, 1879. R.L.J. Fcp. (C. A. Paper).
- (7.) Second Report on the Progress of the Search for Coal in the Cook District, 12th August, 1879. R.L.J. Fcp. (C. A. Paper).
- (8.) Explorations in Cape York Peninsula, 1879-80 (1881). R.L.J. Fcp. (C. A. Paper).
- (9.) Further Reports on the Progress of the Gold Prospecting Expedition in Cape York Peninsula, 16th February, 1880; and Report on the Wild River Tin Mines, 27th October, 1880 (1881). R.L.J. Fcp. (C. A. Paper). With a Geological Map.

- (10.) Six Reports on the Geological Features of Part of the District to be traversed by the Proposed Transcontinental Railway, 12th October, 1881—1st March, 1882 (1886). R.L.J. Fcp. (C. A. Paper). With three Geological Maps.
- (11.) On the Little River Coal Field, near Cooktown, 8th May, 1882. R.L.J. Fcp. (C. A. Paper). With a Geological Map.
- (12.) On the Stanthorpe Tin Mining District, 24th July, 1882. R.L.J. Fcp. (C. A. Paper).
- (13.) On the Tin Mines of Herberton, Western, and Thompson's Creek Districts, and the Silver Mines of the Dry River, 12th May 1883. R.L.J. Fcp. (C. A. Paper). With two Geological Maps and six Plates of Sections.
- (14.) First Sketch of a Geological Map of the Hodgkinson Gold Field. R.L.J. 1883.
- (15.) Progress Report of the Government Geologist for the Year 1883. R.L.J., in Annual Report of the Department of Mines for 1883 (1884), p. 54.
- (16.) On the Hodgkinson Gold Field, 7th August, 1884. R.L.J. Fcp. (C. A. Paper). With two Geological Maps and five Plates of Sections.
- (17.) On the Mount Morgan Gold Deposits, 8th November, 1884. R.L.J. Fcp. (Legislative Assembly Paper). With Geological Map and Sketch Map.
- (18.) On the Gold Deposits of Mount Leyshon, 6th February, 1885. R.L.J. Fcp. (C. A. Paper). With a Geological Map.
- (19.) Progress Report of the Government Geologist for the year 1884. R.L.J., in Annual Report of the Department of Mines for 1884 (1885), p. 50.
- (20.) Progress Report of the Assistant Government Geologist for the year 1884. W.H.R.,\* in Annual Report of the Department of Mines for 1884 (1885), p. 52.
- (21.) On the Gold Fields of Raglan, Calliope, Milton (Norton), and Cania, in the Port Curtis District, and on the Mineral Deposits in the Burnett District. W.H.R. Fcp. (C. A. Paper), 1885. With three Geological Maps and two Plates of Sections.
- (22.) Progress Report of the Government Geologist for the year 1885. R.L.J., in Annual Report of the Department of Mines for 1885 (1886), p. 53.
- (23.) Progress Report of the Assistant Government Geologist for the Year 1885. W.H.R., in Annual Report of the Department of Mines for 1885 (1886), p. 62.
- (24.) On the Burrum Coal Field. W.H.R. Fcp. (C. A. Paper), 1886. With two Geological Maps and three Plates of Sections.
- (25.) On the Gold and Silver Deposits in the neighbourhood of Mount Shamrock. W.H.R. Fcp. (C. A. Paper), 1886.
- (26.) On the Argentine (Star) Silver Mines, Kennedy District. R.L.J. Fcp. (C. A. Paper), 19th October, 1886. With a Geological Map and one Plate of Sections.
- (27.) On the Geology and Mineral Deposits of the country in the vicinity of Clermont. W.H.R. Fcp. (C. A. Paper), 1886. With Geological Map and Plate of Sections.
- (28.) On the Geology and Mineral Resources of the Districts of Kilkivan and Black Snake. W.H.R. Fcp. (C. A. Paper), 1886. With three Geological Maps and one Plate of Sections.
- (29.) On the Gold Deposits in the neighbourhood of Nanango. W.H.R. Fcp. (C. A. Paper), 1886. With Geological Map and two Plates of Sections.
- (30.) Geological Map of Queensland, on the scale of 32 miles to an inch. R.L.J. Issued under the authority of the Department of Public Works and Mines, 1886.

- (31.) Handbook of Queensland Geology. R.L.J. 8vo., Brisbane: Warwick and Sapsford, 1886. Also issued with Essays prepared by the authority of the Executive Commissioners in Queensland for the Colonial and Indian Exhibition, London, 1886.
- (32.) Annual Report of the Government Geologist for the year 1886. R.L.J., in Annual Report of the Department of Mines for 1886 (1887), p. 63.
- (33.) Annual Report of the Assistant Government Geologist for the year 1886. W.H.R., in Annual Report of the Department of Mines for 1886 (1887), p. 65.
- (34.) Geological Map of the City of Brisbane and its Environs, accompanied by a Report. W.H.R. Fcp. (C. A. Paper), 3rd February, 1887.
- (35.) Geological Observations in the North of Queensland, 1886-7. R.L.J. Fcp. (C. A. Paper), 13th April, 1887. With three Geological Maps.
- (36.) Geology of and Mineral Deposits occurring in the country in the neighbourhood of Beenleigh and of the Logan and Albert Rivers. W.H.R. Fcp. (C. A. Paper), 12th May, 1887.
- (37.) On Mineral Lease 276, Watsonville. R.L.J. Fcp. (Legislative Assembly Paper), 14th May, 1887. With a Geological Map.
- (38.) Report on a Cobalt Lode at Black Snake, Kilkivan. W.H.R. Fcp. (C. A. Paper), 1887.
- (39.) On the Geological Features of the Mackay District. R.L.J. Fcp. (C. A. Paper), 8th November, 1887. With three Geological Maps.
- (40.) Report on Glenelg and other Reefs in the neighbourhood of Thano's Creek and Talgai, and certain Mineral Deposits near Stanthorpe. W.H.R. Fcp. (C. A. Paper), 14th May, 1887.
- (41.) Annual Progress Report of the Government Geologist for the year 1887. R.L.J., in Annual Report of the Department of Mines for 1887 (1888), p. 81.
- (42.) Annual Progress Report of the Assistant Government Geologist for the year 1887. W.H.R., in Annual Report of the Department of Mines for 1887 (1888), p. 92.
- (43.) On the Eidsvold Gold Field. W.H.R. Fcp. (C. A. Paper), 1887. With Geological Map and Plate of Sections.
- (44.) Coal Discoveries on the Flinders. R.L.J. Fcp. (C. A. Paper), 23rd January, 1888.
- (45.) Geology of the Russell River. R.L.J. Fcp. (C. A. Paper), 17th March, 1888. With Geological Map.
- (46.) On Limestone District, part of the Palmer Gold Field. R.L.J. Fcp. (C. A. Paper), 18th April, 1888. With a Map.
- (47.) Second Report on the Mount Morgan Gold Deposits. R.L.J. Fcp. (C. A. Paper), 12th December, 1888 (1889). With two Plates of Diagrams and Sections.
- (48.) The Mineral Wealth of Queensland. R.L.J. 8vo., Brisbane: Warwick and Sapsford, 1888. With Map showing the positions of Mineral Fields. Issued for the Queensland Commission, Centennial International Exhibition, Melbourne, 1888.
- (49.) Annual Progress Report of the Geological Survey for the year 1888 (1889). Fcp. (C. A. Paper).
- (50.) On Taranganba Gold Mine. R.L.J. Fcp. (C. A. Paper), 18th May, 1889.
- (51.) On the Albert and Logan District. W.H.R. Fcp. (C. A. Paper), 1889. With Geological Map and Sheet of Sections.
- (52.) On Gympie Gold Field. W.H.R. Fcp. (C. A. Paper), 1889. With two Geological Maps and seven Plates of Sections.
- (53.) Geological Features and Mineral Resources of the Mackay District. A.G.M.\* Fcp. (C. A. Paper), 1889. With Geological Map and four Plates of Sections.

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\* A. Gibb Maitland.

- (54.) Geological Observations at the heads of the Isaacs, the Suttor, and the Bowen Rivers. A.G.M. Fcp. (C. A. Paper), 1889. With three Geological Maps.
- (55.) Report on Geological Specimens from New Guinea. R.L.J. and A. W. Clarke. Fcp. *New Guinea Government Gazette*, 5th June, 1889.
- (56.) Report on Geological Specimens from New Guinea. W.H.R. Fcp. *New Guinea Government Gazette*, 15th August, 1889.
- (57.) On the Sellheim Silver Mines and surrounding District. R.L.J. Fcp. (C. A. Paper), 11th September, 1889. With two Geological Maps and Plate of Sections.
- (58.) Annual Progress Report of the Geological Survey for the year 1889 (1890). With Geological Map.
- (59.) The Coal Measures, Neardie Antimony Mine and Teebar and Culgoa Copper Lodes. W.H.R. Fcp. (C. A. Paper), 1890. With Geological Map and Plate of Sections.
- (60.) On Mount Biggenden Bismuth Mine, Gebangle, and the Mount Shamrock Mine. W.H.R. Fcp. (C. A. Paper), 1890. With a Geological Map and Plate of Sections.
- (61.) Proposed Boring for Artesian Water on the Etheridge and Croydon Gold Fields. R.L.J. Fcp. (C. A. Paper), 18th January, 1890.
- (62.) Proposal to Bore for Artesian Water at Normanton. R.L.J. and A.G.M. Fcp. (C. A. Paper), 20th January, 1890.
- (63.) Brookfield, Pullen Vale, and Moggill Districts. W.H.R. Fcp. (C. A. Paper), 1890.
- (64.) Coal in the Parish of Noosa. W.H.R. Fcp. (C. A. Paper), 29th November, 1890.
- (65.) Proposed Boring for Water at Brisbane. R.L.J. Fcp. (C. A. Paper), 5th March, 1889 (1890).
- (66.) The Tin Mines near Cooktown. R.L.J. Fcp. (C. A. Paper), 6th December, 1890 (1891). With Geological Map and two Sheets of Plans.
- (67.) The Mineral Selections on the Ballandean and Jibbinbar Runs. W.H.R. Fcp. (C. A. Paper), 1890.
- (68.) The Paradise Gold Field. W.H.R. Fcp. (C. A. Paper), 1891.
- (69.) The Chillagoe and Koorboora Mining Districts. R.L.J. Fcp. (C. A. Paper), 6th November, 1890 (1891). With Map and Geological Map.
- (70.) The Geology of the Cooktown District. A.G.M. Fcp. (C. A. Paper), 1891. With Geological Map and two Sheets of Sections.
- (71.) Geology and Mineral Resources of the Upper Burdekin. A.G.M. Fcp. (C. A. Paper), 1891. With Geological Map and two Sheets of Sections.
- (72.) The Coolgarra Tin Mines and Surrounding District. A.G.M. Fcp. (C. A. Paper), 1891. With Geological Map and Sheet of Plans.
- (73.) The Cape River Gold Field. W.H.R. Fcp. (C. A. Paper), 1891. With two Geological Maps and two Plates of Sections.
- (74.) Notes on Broken Hill (N.S.W.) R.L.J. Fcp. (C. A. Paper), 15th May, 1891.
- (75.) Geology of Magnetic Island. A.G.M. Fcp. (C. A. Paper), 1892.
- (76.) Second Report on Gympie Gold Field. W.H.R. Fcp. (C. A. Paper), 1891.
- (77.) Annual Progress Report of the Geological Survey for the year 1890. With Plate of Sections, and Geological Maps of Cania and part of Gilbert Gold Fields. Fcp. (C. A. Paper), 1891.
- (78.) Report on Moondilla Gold Field. R.L.J. Fcp. (C. A. Paper), 1891.
- (79.) Report on an Alluvial Cinnabar Deposit near Kilkivan. W.H.R. Fcp. (C. A. Paper), 1892.

- (80.) Report on the New Discovery of Coal near the Callide Creek, Port Curtis District. W.H.R. Fcp. (C. A. Paper), 1891.
- (81.) Report on Sapphire Deposits and Gold and Silver Mines near Withersfield. R.L.J. Fcp. (C. A. Paper), 1892. With a Map.
- (82.) Report on the Kangaroo Hills Silver and Tin Mines. R.L.J. Fcp. (C. A. Paper), 1892. With a Geological Map.
- (83.) Third Report on the Mount Morgan Gold Deposits. R.L.J. Fcp. (C. A. Paper), 1892. With Maps, Views, and Sections.
- (84.) Report on the Styx River Coal Field. W.H.R. Fcp. (C. A. Paper), 1892. With Geological Map.
- (85.) Geological Observations in British New Guinea in 1891. A.G.M. Fcp. (C. A. Paper), 1892. With Geological Maps and Sections.
- (86.) Report on Olsen's and Johannsen's Caves, near Rockhampton. W.H.R. Fcp. (C. A. Paper), 1892. With Map and Plate.
- (87.) Report on Supposed Gold-bearing Quartzites, near Traveston and Glastonbury; and on Hyalite in Basalt, near Cooran. W.H.R. Fcp. (C. A. Paper), 1892.
- (88.) Annual Progress Report of the Geological Survey for the Year 1891. Fcp. (C. A. Paper), 1892.

From February, 1889, to his death, on 10th April, 1891, Mr. James Smith was employed as Collector for the Survey. Mr. Smith had for many years previously been collecting fossils and other Natural History specimens, many of which he donated to the Geological Survey. His appointment to the staff of the Survey enriched the collections with representative fossils from Rockhampton, Langmorn, Raglan, Broadsound, Baccaldine, the Drummond Range, and the Ipswich Coal Field. Mr. Smith, who was an enthusiastic naturalist, wrote a Paper "On the Discovery of Fossils at Rockhampton,"\* and contributed numerous articles to the Natural History Society of Rockhampton and the *Rockhampton Bulletin*. His place on the Survey will be very difficult to fill.

Mr. William Wood acted as Caretaker to the Survey Museum from 28th May, 1886, to 31st May, 1891, when he retired, owing to the failure of his health. His place is now filled by Mr. Thomas Sythers.

My Colleague, Mr. Robert Etheridge, Junr., has acted as Consulting Palæontologist in an honorary capacity ever since my arrival in Queensland. His connection with the British Museum, the Australian Museum, and the Geological Survey of New South Wales, and his former connection with the Geological Surveys of Victoria and Scotland, rendered him peculiarly fitted for this task. To my association with him in Scotland, I owe a friendship which has been very valuable to me as well as to the Colony of Queensland. The magnitude of Mr. Etheridge's labours on our behalf may be estimated by his contribution to the present work.

For some time back I have urged on the Government the attachment of a Chemist to the staff of the Survey. The three working members of the staff are chiefly employed, and can always be most profitably employed in the field, and have little time to devote to micro-petrographical work or to the chemical questions which arise in the course of their observations. I am, however, enabled through the kindness

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\* Proc. Austr. Assoc. Adv. Sci., 1888, vol. I., p. 300.



of my friend Mr. A. W. Clarke, F.G.S., of Charters Towers, formerly Government Mineralogical Lecturer, to furnish an extensive series of Petrographical Notes on Queensland Rocks, the result of at least two years' assiduous labour.

It was originally my intention to include in the present volume all that I could say regarding the Mines of the Colony, but I had not made great progress when I became convinced that this would not only lengthen the work beyond all reasonable limits, but would also be a source of further delay. Notes will be found in the following pages on most of the Mining Districts, and I have drawn freely for statistics, &c., on "The Mineral Wealth of Queensland,"\* taking care, however, to bring the information up to date where it was possible; but the Economic Geology of Queensland must form the subject of another volume. I am informed that The Honourable W. O. Hodgkinson, Minister for Mines and Education, has a Work on this subject in preparation.†

ROBERT L. JACK.

Brisbane, 8th August, 1892.

## PALÆONTOLOGY.

The investigation of the material for the Palæontology of Queensland and New Guinea was commenced in 1881, and has progressed at intervals since that date as opportunity would permit during the leisure time of the Writer.

The Palæontology of Queensland has hitherto been treated only in a disjointed and desultory manner, whilst that of New Guinea, to all intents and purposes, is untouched and hardly known. The present attempt is the first on which a collective account of the Fossil Organic Remains of these countries has appeared.‡

Up to 1872 Sir Richard Owen's masterly descriptions of the large extinct *Marsupialia*, a notice by Prof. (now Sir) F. McCoy on some Reptilian Remains, and a few *Mollusca*, and the more extended essay of the late Mr. Charles Moore on the Mesozoic Fossils of Wollumbilla, were the only Memoirs of any importance extant. In that year there appeared an account of the gatherings of the late Richard Daintree, C.M.G., by Messrs. Etheridge and Carruthers. Since then large collections have been made, chiefly through the labours of my Colleague, Mr. R. L. Jack, his Assistants, Mr. W. H. Rands and Mr. A. Gibb Maitland, and by the late Mr. James Smith, of Rockhampton, first as a private individual and afterwards as Collector for the Geological Survey. In addition many separate Papers have appeared, notably "Carboniferous Marine Fossils," "Mesozoic Fossils from the Palmer River," and "Fossil Flora of the Coal Deposits of

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\* See No. 48 in the preceding list of Publications.

† Throughout the Work the paragraphs written by my Colleague and myself are distinguished by an initial (E. or J.) at the end.

‡ With the exception of a short Paper by the Writer, "On our Present Knowledge of the Palæontology of New Guinea," in Records of the Geological Survey of New South Wales, vol. ii., p. 172. Sydney: Government Printer: 1890.

Australia," by the late Rev. J. E. Tenison Woods; Dr. O. Feistmantel, "Palæozoische und Mesozoische Flora"; the "Palæozoic Corals of North Queensland," by Prof. H. A. Nicholson and the Writer; the "Fossils of the Bowen River Coal Field," by the Writer; and others of minor importance.

The work may be divided into two parts, the first treating of the Palæontology of Queensland; the second recording what little is known of that of New Guinea. In describing the Queensland Organic Remains, I have grouped them in very general and broad geological sections, consequent on the present tentative grouping of the sedimentary deposits. The general determination of the species has been rendered more difficult than ordinary by the poor state of preservation of a large number of the specimens. This will, to a great extent, explain the number of species simply indicated (*sp. ind.*) and not named, as I thought it better to figure such when possessing any marked character, with the view of future determinate recognition. The species described represent not only those which have come under the eye of the Writer, but others published by various Authors, chiefly in the "Annals and Magazine of Natural History" and the "Quarterly Journal of the Geological Society of London." In many cases descriptions are quoted verbatim, with the kind permission of Dr. Francis on the one hand, and the leave of the Council of the Geological Society on the other. In such cases the Author's name is invariably given at the end of the extract in brackets. Similarly lengthy extracts have been made from a Paper of my own in the "Proceedings of the Royal Physical Society of Edinburgh," again with the kind permission of the Council.

I have endeavoured to arrange the subject matters under each species in the clearest possible manner. Following the name of the fossil will usually be found a brief synonymy, detailing only the principal works in which previous allusions to it will be found. To the synonymy succeeds the specific description when it has been found requisite to give one, otherwise general observations follow next, and the account is completed by the locality and horizon. In the synonymy I have endeavoured strictly to adhere to priority in the use of specific names, but I wish it to be distinctly understood that newspaper articles (a medium unfortunately adopted by more than one Australian Writer of note) have been purposely ignored. In the paragraph relating to the locality and horizon, the former is invariably followed by the name of the collector, or recorder, when known to me, and in italics to give it greater prominence; but when the name of the collector is unknown, that of the describer is substituted. I have also endeavoured, but not always with success I am afraid, to indicate the Collection or Museum containing the specimens mentioned; and the absence of such reference will, in the great majority of instances, infer that the fossils are in that of the Queensland Geological Survey.

I am indebted to a large number of scientific friends for most cordial assistance. Had it not been for the constant kindness and encouragement of my old Colleague and Co-Author, the many difficulties which crop up in the production of a Work of this kind would probably have proved fatal to it. At no time was this more felt than on its resumption after my arrival in Sydney, when the sad lack of Palæontological literature in the Colonies was forcibly brought home to me.

For assistance in their respective special groups I have to acknowledge my great indebtedness to Profs. H. A. Nicholson, M.D., of Aberdeen; T. Rupert Jones, F.R.S., of London; Ralph Tate, F.L.S., of Adelaide; Sir F. McCoy, F.R.S., of Melbourne; T. W. Edgeworth David, B.A., Sydney; the late Dr. P. H. Carpenter, F.R.S., of Eton, and the late Dr. T. Davidson, F.R.S., of Brighton (Eng.); Messrs. Edgar Smith, of the British Museum; Stuart Ridley, late of the same Institution; and John Brazier, C.M.Z.S.; George Sweet, Melbourne; and T. Whitelegge, of the Australian Museum.

For general assistance and advice I am equally beholden to Mr. R. Etheridge, F.R.S., and Dr. Henry Woodward, F.R.S., of the British Museum.

Dr. G. J. Hinde, of Mitcham (Eng.), has most kindly conducted an original investigation of the interesting Cretaceous Sponge, *Purisiphonia Clarkei*, for these pages; and I am thus able to afford a much more detailed account of this species.

But to none am I more indebted than to Messrs. Robert Kidston, of Stirling, N.B., and R. B. Newton, of the British Museum. The former conducted the examination of the Palæozoic and Mesozoic Plants, and drew up a lengthy series of notes, which have proved of the greatest assistance. After my departure from London, Mr. Newton undertook the task of superintending the drawing of the lithographic plates, and general custody of the figured specimens. This, no light duty, has greatly contributed to the completion of this undertaking.

The success of all works on Palæontology depends in a great measure on the illustrations; and I was fortunate in securing the careful and well-known artistic skill of my friends, Messrs. Charles Berjeau and Percy Highley. Taking into consideration the exceptional circumstances under which the plates were drawn, they reflect the greatest credit on these gentlemen. Additional plates (Nos. 37 to 44 inclusive) have been kindly undertaken by Mr. G. H. Barrow, of the Australian Museum.

Messrs. Richard Hall and W. H. Brown, the former of, the latter late of, the Department of Geology, British Museum, have rendered me very valuable assistance—the one in preparing microscopic sections and developing specimens, the other in helping to unravel many difficult questions of bibliography.

Finally, as to the sources of the specimens described. The major portion are, of course, the result of the Geological Explorations of my Colleague and his Assistants. In addition to this, a valuable collection from the Rockhampton District was contributed by the late Mr. James Smith, of Rockhampton, who was also most kind in affording general local information. Mr. C. W. De Vis, Curator of the Queensland Museum, forwarded me another large series from the same neighbourhood, and many fine Cretaceous fossils from various localities. Besides these the cabinets of the British Museum, Australian Museum, and the Mining and Geological Museum, Sydney, have been laid under contribution. I am indebted to the Rev. H. H. Winwood, M.A., for the loan of the few existing specimens of the late Rev. W. B. Clarke's Collection, described by the late Mr. Charles Moore,\* now in the Museum of the Philosophical

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\* Quart. Journ. Geol. Soc., 1870, xxvi., pp. 226-261. With the exception of these specimens, the whole of Mr. Clarke's Collection was burnt in the Garden Palace fire at Sydney in 1882.

Society of Bath (Eng.) The gatherings of my old Colleague, the late Richard Daintree, described by my Father,\* have become much scattered, and it is difficult to refer to their present place of exhibition. The Corals are in the British Museum, and I have received some of the Mollusca from the Queensland Museum, but they do not all appear to be there. I was permitted to borrow a few fossils from the Collection of the late Rev. J. E. T. Woods, and through the courtesy of the late Prof. W. H. Stephens, M.A., access was granted to many of the plants described by Mr. Woods in his Memoir on the "Flora of the Coal Deposits of Australia,"† now in the Macleay Museum at the University of Sydney.

A Bibliography of the principal Papers relating to the Palæontology of Queensland is given herewith.

It may be necessary to point out that as it is now some time since the Plates were printed off, the titles affixed to some of them are not in accord with the classification finally adopted, and reflect opinions now abandoned as to the age of certain formations. This, however, is of little importance, as the changes adopted will be noted in the text.

ROBERT ETHERIDGE, JUNR.

Sydney, 10th August, 1892.

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\* Quart. Journ. Geol. Soc., 1872, xxviii., pp. 317-350.

† Proc. Linn. Soc. N.S. Wales, 1883, viii., pt. 1, pp. 37-167.





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- BENNETT, G.—Notes on the *Chlamydosaurus*, or Frilled Lizard, of Queensland (*C. Kingii*, Gray), and the Discovery of a Fossil Species on the Darling Downs, Queensland. *Proc. R. Soc. Tas.* for 1875, pp. 56-58.
- BOULENGER, G. A.—On the Systematic Position of the Genus *Miolania*, Owen (*Ceratohelys*, Huxley). *Proc. Zool. Soc.* for 1887, Pt. 3, p. 554; *Ann. and Mag. Nat. Hist.*, 1889, iii., pp. 138-141.
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- CARRUTHERS, W.—Notes on Fossil Plants from Queensland, Australia. *Quart. Journ. Geol. Soc.*, 1872, xxviii., pp. 350-360, pls. 26 and 27.
- CARTER, H. J.—Emendatory Description of *Purisiphonia Clarkei* (Bk.), a Hexactinellid Fossil Sponge, from N.W. Australia. *Ann. and Mag. Nat. Hist.*, 1878, i., pp. 376-379.
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- Id.* On the *Dinornis* and Saurian Remains in Australia. *American Journ. Sci.*, 1870, xlix., p. 273.
- Id.* Remarks on the Sedimentary Formations of New South Wales, 1870. Sydney, 8vo. (and later Editions).
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- Id.* Report on the Cape River Diggings, and the latest Mineral Discoveries in North Queensland. Pp. 7. Fcp. Brisbane, 1868. [Discovery of *Belemnites*.]
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- Id.* Notes on New Erian (Devonian) Plants. *Quart. Journ. Geol. Soc.*, 1881, xxxvii., pp. 299-308, pls. 12 and 13. (*Dicranophyllum australicum*.)

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- Id.* On *Brachalleles Palmeri*, an Extinct Marsupial. *Proc. Linn. Soc. N.S. Wales*, 1883, viii., Pt. 2, pp. 190-193.
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- Id.* On a Fossil Humerus [*Nototherium*? from Darling Downs]. *Proc. Linn. Soc. N.S. Wales*, 1883, viii., Pt. 3, pp. 404-408.
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- Id.* On an Extinct Mammal of a Genus apparently new [*Owenia*, De Vis], *Proc. R. Soc. Queensland*, 1887, iv., pp. 99-106, pls. 1-4.
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# ERRATA.

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*N.B.—The pagination is counted as a line.*

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**PAGE.**

- 7.—Line 33, for "Creek" read "River."  
 10.—Line 35, for "CREEK" read "RIVER."  
 21.—After extract from *Brisbane Courier* referring to Last Call Mine, Cloncurry, refer to Note at foot of p. 149.  
 72.—Line 24, for "*bisucleata*" read "*bisulcata*."  
 73.—Second footnote, for "Durandin" read "Durandur."  
 112.—Last line, *dele* "Aplin."  
 159.—Line 34, for "*duodecemcostata*" read "*duodecimcostata*."  
 170.—Line 9, for "Lower" read "Middle."  
 193.—Last line, for "No. 5" read "No. 3."  
 245.—Transfer first footnote to bottom of page 244.  
 269.—Line 23, for "ILLAWARENSIS" read "ILLAWARRENSIS." Line 26, for "p. 301" read "p. 163."  
 273.—Line 42, for "*R. L. Jack*" read "*The late James Smith*."  
 274.—First footnote, before *Macrodon* insert =.  
 308.—Line 25, for "A" read "E."  
 311.—After line 44 add as in Appendix VIII.  
 312.—Line 39, for "twelve" read "thirteen," and for "four" read "five."  
 315.—After line 23 add as in Appendix IX.  
 394.—Line 23, for "*B. Canhami*" read "*Belemnites Canhami*."  
 397.—Line 4, for "*Selheimi*" read "*Sellheimi*." Line 14, for "*apendiculatus*" read "*appendiculatus*."  
 401.—Line 27, *dele* "Cloncurry."  
 406.—Lines 6 and 8, for "*Crispii*" read "*Crispii*."  
 423.—At end of first footnote insert "*R.L.J.*" At end of second footnote insert "*J.B.H.*"  
 434.—Line 5, for "Bed" read "Beds."  
 457.—Line 3, for "Pl. 20, figs. 1, 3, 5, 7, and 10" read "Pl. 23, figs. 3, 5, 7, and 10, ? figs. 1 and 2."  
 475.—Line 29, for "*Macrocallista Taylora*" read "*Macrocallista plana*."  
 478.—Line 12, for "*PALÆOMÆRA*" read "*PALÆOMCERA*." Line 14, for "*PALÆOMÆRA*" read "*PALÆOMCERA*."  
 490.—Line 3, for "? Plate 39" read "? Plate 29."  
 511.—Line 40, for "Down" read "Downs."  
 512.—Line 31, for "Mitchell" read "Maranoa." Line 32, for "following" read "foregoing."  
 549.—Line 8, for "parallel" read "meridian."  
 644.—Between lines 35 and 36 add "*LIMNEA VINOSA*, *A. Adams* and *Angas*."  
 672.—Line 38, for "Strutchbury" read "Stutchbury."  
 736.—Third line of footnote, after "crystals" insert "of augite."



# GEOLOGY AND PALÆONTOLOGY OF QUEENSLAND AND NEW GUINEA.

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## CHAPTER I.

### INTRODUCTORY.

THE eastern third, or perhaps nearly the half, of Queensland is the remnant of a lofty tableland, composed of hard materials which have resisted denudation, and which culminates, at an elevation of 5,150 feet, in the Bellenden-Ker Ranges.\* This tableland is the chief seat of the mineral wealth of the Colony. Its eastern edge presents a series of escarpments, or a short and steep slope down to the Pacific. This elevated tract generally robs the rain-charged clouds which rise up from the ocean, and a fairly watered and well-timbered country is the result. The generally indifferent character of the soil accounts for the fact that the grasses, although fair, are not first-rate for pastoral purposes. Where, however, basaltic plateaux occur, agricultural soils of the highest quality are produced, and are often covered by dense tropical jungles, watered by copious and perennial streams.

Besides granites and syenites, partly of plutonic and partly of metamorphic origin, and basic igneous rocks, both bedded and intrusive, and of various ages, this coast region contains a series of stratified rocks, of which the older members are more or less metamorphosed. Among these, and recognisable by their fossil contents, are formations related homotaxially to the Middle Devonian (Burdekin), the Permo-Carboniferous (Gympie, Star, and Lower, Middle, and Upper Bowen), the Trias-Jura (Burrum and Ipswich), the Cretaceous (Rolling Downs and Desert Sandstone), the Miocene and Pliocene (Lower and Upper Volcanic Series with associated Drifts), the Post-Tertiary, and the Recent.

The western interior presents a totally different aspect. The tableland slopes gradually westward and falls away towards the Gulf of Carpentaria and the south-western boundaries of the Colony. The greater part of the interior is covered by soft stratified rocks of Cretaceous age which weather into a fine soil, supporting nutritious grasses, but almost treeless except in the south-western districts, where thick scrubs of mulga and gidya cover a region which is perhaps partly of Tertiary age. The rainfall over this area is, however, comparatively small, and the watercourses are ill-defined and dried up to waterholes during the greater part of the year. This defect on the part of nature is rapidly being remedied by the sinking of artesian wells. At intervals portions of the interior are occupied by detached tablelands of what has been aptly named "Desert Sandstone," supporting, as a rule, only spinifex grass and stunted timber. The

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\* Report on the Bellenden-Ker Range, North Queensland, by A. Meston. Fop. Brisbane: by Authority: 1889.

evidences that the Desert Sandstone once covered the whole of the western interior are unmistakable, and it is matter for congratulation that it has been so extensively denuded as to lay bare, over an immense area, the rich soil-producing Cretaceous rocks. Between the Desert Sandstone and the Recent deposits is a series of drifts containing the remains of extinct marsupials and other animals.

In the following chapters, the various formations which tell a part of the geological history of the Colony are described in detail.

In my "Handbook of Queensland Geology" (Brisbane, 1886), of which the present work may to some extent be regarded as an expansion, I favoured the use of local names for the various formations described. In the present work, although the local names have been for the most part retained, I have ventured to point out the probable relations of the Queensland formations to those of Europe.

In a highly philosophical essay, Mr. R. M. Johnston, F.L.S., Government Statistician of Tasmania, asked the members of the Australasian Association\* the question, "How far can Australian geologists safely rely upon the order of succession of the characteristic genera of fossil plants of a far distant region in the determination of the order and relationship of Australian terrestrial formations?" and answered for them, that—"Australian geologists cannot with safety so rely, and that even within the wide borders of Australia considerable differences may be expected in the biology and minor subdivisions of systems as developed in some of its widely separated colonies." I, for one, heartily concur in this verdict, and I know that my Colleague in the palæontological work has been fully alive to the difficulties attending classification when based upon palæobotanical evidence alone. In dealing with animal remains, however, we trace a parallelism between the formations of Australia and Europe, although in view of the wide distance between the two regions we do not claim more than homotaxial relationship for the formations to which in Queensland we have attached European names. We must, however, point out that the *order* of succession of the Queensland formations bears a general and striking resemblance to that of the European.

These sedimentary formations are described in the order indicated in the following table, commencing with the oldest or lowest.

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\* Proc. Austr. Assoc. Adv. Sci. for 1888 [1889] p. 302.



## CLASSIFICATION AND SUPPOSED AFFINITIES OF QUEENSLAND FORMATIONS.

FORMATIONS.		
POST-TERTIARY.	Post-Pliocene.	Recent and Post-Pliocene Recent Alluvia Sand Dunes Raised Beaches High-level River and Lake Drifts Cave Breccias Bone Drifts
		*****
TERTIARY.	Pliocene.	Upper Volcanic, and Drifts (? Pliocene)
	Miocene.	Lower Volcanic, and Drifts (? Miocene)
MESOZOIC.	Lower   Upper Cretaceous.	Desert Sandstone
		***** Rolling Downs
	Lower   Upper Trias-Jura.	Ipawich
		***** Burrum
PALEOZOIC.	Permo-Carboniferous.	Upper Bowen
		Middle Bowen
		Lower Bowen
		***** Star
		***** Gympie
	Middle Devonian.	***** Burdekin
		*****
	Silurian ? Cambrian ? Laurentian ?	Slates, Schists, &c., of undetermined age

NOTE. \*\*\*\*\* denotes an unconformable succession

## CHAPTER II.

### PLUTONIC AND METAMORPHIC ROCKS.

(GRANITE, SYENITE, AND ACID CRYSTALLINE ROCKS.)

**Mineral Areas—viz., Herberton Tin Field, Kangaroo Hills and Eunning Creek Silver and Tin Fields, Annan and Bloomfield Tin Fields, Ravenswood Gold and Silver Fields, Sellheim Bismuth Mines, Croydon Gold Field, Etheridge Gold Field, Eidsvold Gold Field, Mount Perry Copper Mine, Tenningering, Boolboonda, Molangul, and Normanby Gold Fields, Jimna and Goocroomjam Gold Fields.**

IN denoting the whole of these rocks, on the ground of their lithological relationship, by a single colour, I am well aware that the highest purpose of a geological map is not served, but it seems all that can be done until a great amount of detailed surveying, accompanied by micro-petrographical study, can be carried out.

In some regions the Granites and Syenites are clearly metamorphic. In others, whether originally of metamorphic or of plutonic origin, they are covered by the oldest fossiliferous deposits of the Colony. Sometimes they are intruded among the earlier rocks. Sheets of quartz-porphyry in the neighbourhood of Townsville have been intruded among rocks containing *Glossopteris*, and presumably of the age of the Bowen River Coal Field. The Hon. A. C. Gregory refers \* to “the extensive development of the porphyritic rocks which, rising through the Carbonaceous strata [Ipswich Formation], form the range dividing the valley of the Mary River from the Maroochy River.”

The same Author thus refers to the porphyries of the Moreton and Darling Downs districts †:—“The porphyry consists of a pale-brown paste with minute felspathic crystals, though it sometimes varies so as to consist of very small grains of quartz with minute cavities, containing oxide of iron, resulting from the decomposition of pyrites. Occasionally it is vesicular, and has the aspect of trachyte.

“The age of this rock is greater than that of the basalts, which cut through and overlay it, though it often occurs that the basalt has found vent through the same fissures as the porphyry, and formed spurs to the more elevated masses of the older igneous rock, a feature which is especially developed on both sides of the Main Range, near Cunningham’s Gap, where Mount Cordeaux, Mount Mitchell, and Spicer’s Peak are porphyry, and the subordinate ranges basaltic.

“On the other hand the age is less than that of the Carbonaceous Series [Ipswich Formation], as the porphyry in all cases is found superimposed on the sedimentary strata.

“The porphyritic rock is chiefly developed in the southern portion of the Moreton district, where it forms all the remarkable peaks on the Great Dividing Range from the head of Laidley Creek to the southern boundary of the Colony, and thence along the Macpherson Range, which separates the Logan River from the Clarence, Richmond, and Tweed Rivers.

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\* Report on the Geology of part of the District of Wide Bay and Burnett. Fcp. Brisbane: by Authority: 1876.

† Report on the Geological Features of the South-eastern Districts of Queensland. Fcp. Brisbane: by Authority: 1879.

"The general aspect of these hills is a succession of sharp peaks, formed by the upheaval of portions of strata, with a change of angle, one side of each hill being a nearly even slope, with a steep escarpment on the opposite side. The steep side, however, shows a columnar structure, which is vertical, and not a right angle, with the slope on the opposite side of the hills. Some of these peaks, as Mount Barney, Wilson's Peak, Mount Lindsay, and Mount Mitchell, have an altitude of 3,000 and 4,000 feet, and show the porphyry to exceed 2,000 feet, but in every case resting on carbonaceous rocks [Ipswich Formation]. Though the porphyry sometimes flowed over considerable areas in thin sheets, and shows a cellular structure, yet the greater part must have been less fluid when erupted than the basalts.

"Besides the principal mass between Cunningham's Gap and Mount Lindsay, there are several detached points of eruption, as Knapp's Peak, Mount French, Mount Edwards, Flinders Peak, and Mount Goolman, all situate to the south of Ipswich, Mount Esk, on the Upper Brisbane River, Kangaroo Point, Bowen Terrace, and Spring Hill, in the town of Brisbane; also the Glasshouse Mountains.

"In the town of Brisbane the porphyry is erupted through the Devonian slate, fragments of which are disseminated through the porphyry, while portions of silicified wood are embedded in the lower surface of the erupted mass."

In another place it will be seen that the Kangaroo Point and Bowen Terrace rock is regarded as an altered brecciform ash rather than as a true crystalline rock. The Glasshouse Mountains, also, were regarded by Stutchbury as altered sandstone.

The granite of the Pentland Hills is metamorphic, "alternate layers of coarser and finer material betraying its originally sedimentary origin," as has been observed by Daintree, and subsequently by myself.

As many of the most important metalliferous fields of the Colony occur in the group of rocks now referred to, lithological observations will be found in the descriptions of the localities. The reader is also referred to Mr. A. W. Clarke's *Micro-Petrographical Notes* printed with this work.

## MINES CONNECTED WITH GRANITIC, &c., ROCKS.

### HERBERTON TIN FIELD.

This field, which is one of the most important sources of lode tin in Australia, was only discovered in 1879.

The "country-rock" of this field is divisible into three classes: (1) a perfectly normal granite; (2) a porphyry of quartz and felspar (quartz predominating), with mica as an occasional or accidental and not essential constituent; and (3) highly inclined greywackes, quartzites, and shales—belonging, there is every reason to believe, to the Gympie Formation. The rocks of the first class, which extend northward from Watsonville, appear to be nearly barren of tin ore, at least in the neighbourhood of Herberton and Watsonville, although at Return Creek they contain tin lodes. Those of the second were for a time regarded as the only seat of the tin deposits; but it is now questionable whether those of the third class do not excel them in this respect.

The porphyry rocks are intersected in every direction by large "elvan" dykes (compact, highly silicated, yellowish or greenish felspar base, with blebs of quartz).<sup>\*</sup> These elvans contain a good deal of arsenical pyrites, but—except in the case of the Three Star Mine—have not yet proved to be tin-bearing to any great extent. Dykes of quartzose chlorite and quartzose serpentine—probably originally intruded among the porphyry as quartz-diorites, or as rocks more or less of basaltic type, and subsequently

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<sup>\*</sup> See Mr. Clarke's *Micro-Petrographical Notes*.

metamorphosed—form the chief matrix of the tin ore in the porphyry country. The ore (binoxide of tin) occurs in floors, veins, or pipes, among the joint-planes of the dykes. It is rarely crystalline; but occurs either in amorphous masses, almost chemically pure, or intermixed with the dyke rock. Sometimes, as in the Bradlaugh Mine, the ore is so finely disseminated through the dark chlorite matrix as not to be distinguishable by the naked eye. These "chlorite ores" generally weather of the colour characteristic of iron peroxide, and in such cases the tin ore is rather more obvious. Fluorspar and wolfram are associated with the ore, but tourmaline is of rather rare occurrence.

It seems most probable that the tin first came up in solution after the consolidation of the dykes and has been deposited along their walls and among the fissures and joint-planes which traversed them. A re-solution of the tin ore probably took place simultaneously with the metamorphism of the dykes; and as the metamorphosed dykes had probably a new joint system developed in them, a further concentration of the ore may have taken place.

Considerable difficulties were at first experienced in following down the apparently capricious ore deposits, and the miners were haunted by doubts as to their continuance at greater depths. It has always seemed to me that their intimate connection with dykes was a sufficient guarantee of their great vertical range. The Great Northern, which has maintained from the beginning its position as the leading mine in the porphyry country, is now turning out ore from the 400-feet level.

In the sedimentary country-rock the group of mines now united in the North Australian Lease, near Watsonville, was the first to attract attention. In these mines, especially in the North Australian and Ironclad, the lodes, although themselves sometimes poor for a distance, sent off huge "carbonas" of tin and copper ore along the bedding-planes of the shales and greywackes. In 1883-6, this group of mines yielded 1,287½ tons of dressed tin ore, valued at £64,382. Important discoveries of silver and copper ores in this country have recently been reported.

More recently very important lodes of tin ore have been opened up in the sedimentary rocks at Irvinebank (Great Southern, &c.), in Glen Linedale, and at Denny and Dogherty's Camp. In the Irvinebank lodes the ore is generally of the "chlorite" type, and in the Great Southern Mine it is associated with arsenical pyrites, bismuth, stibnite, &c. In the Gordon, in Glen Linedale, the ore impregnates a country-rock of hard, fine-grained, siliceous, and talcose sandstone. At Denny and Dogherty's Camp very fine crystals of tin ore are disseminated through a chloritic matrix in lodes which coincide with the bedding of the country-rock (pebbly grits).

There is little doubt that the stanniferous sedimentary rocks of this district are part of the same mineralised belt which has produced the lead and silver ores of Mount Albion and the Dry River.

Considering the amount of lode tin obtained in the district, the yield of stream tin has been insignificant. A considerable quantity, however, has been taken from a deep lead covered by basalt in the valleys of Nigger Creek and the Wild River.

For detailed information regarding the lodes the reader may be referred to—

- (1) Report (R.L.J.) on the Wild River Tin Mines, 27th October, 1880, in Further Reports on the Progress of the Gold Prospecting Expedition in Cape York Peninsula, 1881.
- (2) Report (R.L.J.) on the Tin Mines of Herberton, &c., 1883.
- (3) Report (R.L.J.) on Mineral Lease 276 (North Australian), Watsonville, 1887.
- (4) Report (R.L.J.) on the Chillagoe and Koorboora Mining Districts, 1891.

- (5) Report (A. Gibb Maitland) on the Coolgarra Tin Mines and Surrounding District, 1891.  
 (6) Mineral Lands Commissioner's Reports in Annual Reports of the Department of Mines.

## YIELD OF HERBERTON TIN FIELD.

Year.	LODE TIN ORE.		Stream Tin Ore.	Total.	Value.	Remarks.
	Stone Crushed.	Yield of Black Tin.				
	Tons.	Tons.	Tons.	Tons cwt.	£	
*1879	...	...	...	131 9	5,260	Exported
*1880	...	...	...	193 11	7,740	"
*1881	...	...	...	1,183 10	47,340	"
*1882	...	...	...	1,810 2	72,400	"
†1883	12,405	2,646	...	...	...	Raised
†1883	" Bagging Ore "	100	...	3,346 0	109,740	"
†1883	...	...	600	...	25,200	"
†1884	11,031	1,902	...	2,352 0	68,474	"
†1884	...	...	450	...	16,200	"
†1885	12,334	2,096	250	2,346 0	117,787	Raised; 651 tons black tin smelted at Irvinebank yielded 438 tons tin
†1886	14,811	2,198	...	2,448 0	109,920	Raised; 666½ tons black tin smelted at Irvinebank yielded 416½ tons tin
†1886	...	...	250	...	13,000	"
†1887	12,142	1,508	300	1,808 0	126,560	Raised
†1888	11,159	1,390	171	1,561 0	78,150	"
†1889	14,476	1,561	258	1,818 0	90,900	"
†1890	13,700	1,690	341	2,031 0	104,050	"
		Totals	...	21,028 12	992,721	

## KANGAROO HILLS AND RUNNING CREEK TIN AND SILVER FIELDS.

Stream tin ore has been worked on Running Creek as far back as 1875, but no records of the output are now obtainable. The following account of this district is taken from a Report † on the Geology and Mineral Resources of the Upper Burdekin, by Mr. A. Gibb Maitland:—

"There is no map in existence showing the relations which the various claims and creeks on the Kangaroo Hills Tin Field bear to one another.

"The larger portion of the stream tin workings exists near the confluence of Sandy and Prospectors' Creeks—tributaries of Oakey Creek—at an estimated altitude, by aneroid, of 2,113 feet above the level of the sea.

"At the time of my visit to the field, in June, 1890, it was practically deserted. A few men were at work. In some cases the creeks and gullies were being 'raked' for the second or third time.

"The ore of tin obtained throughout the field is the binoxide (cassiterite), which occurs in rounded fragments and broken crystals, generally of a reddish colour, and of no very great size. In some of the claims I saw a few of an amber colour, but they did not appear to be very common.

\* From Return to the Legislative Assembly of Tin Ore exported from Tinaroo District, 1886.

† From Mineral Lands Commissioner's Report in Annual Reports of the Department of Mines.

‡ Fcp. Brisbane: by Authority: 1891.

"Along with the tin in the wash there were a few topazes and a little magnetite.

"The washdirt rests directly upon an uneven surface of granite. A section of this is well seen in a claim, originally part of the old P.C., viz.:—

(a) Stratified gritty sand, of a yellowish red colour, with a somewhat gravelly base, and varying in thickness from 10 to 14 feet.

(b) Cement, the matrix being a clay of a bluish-white colour, though often stained yellow. Of this there are from 3 to 4 feet.

It is in this cement, which contains boulders of rocks of the same nature as that forming the surrounding country, that the cassiterite occurs in irregular patches. A small quantity of tin, but of no commercial importance, is met with in the upper stratified sand. It is a noteworthy circumstance that the ground to the south of Prospectors' Creek contains a fair quantity of tin in the surface débris, but, as yet, search has failed to discover the lode from which the tin crystals undoubtedly came.

"There are reefs and dykes from which tin has been derived, scattered over a fairly wide extent of country; but upon none of them has any great amount of work been done up to the present. Some of the dykes bear a marked resemblance to those in the Western and Coolgarra districts.

"These dykes are intrusive basic igneous rocks. So far as is at present known, these do not attain any very great thickness, nor does their horizontal extension appear in this district to be very great.

"Two leases have been taken up—the 40-acre lease, and the 60-acre lease; these are situated about 8 to 9 miles east from Kangaroo Hills Station.

"In the 40-acre lease, situated on the eastern bank of the gully, a tributary of the Douglas, a cutting has been put in on the face of the hill upon a tin-bearing lode in granite country, which appears to trend north-east and south-west. A section across this lode shows on the north about 30 inches of gangue made up of quartz and chlorite, with the binocide of tin disseminated through it. Small quantities of the blue and green carbonates of copper are also contained in the gangue. Adjoining this to the south there is a thickness of about 30 inches of quartz. A thin film of serpentine separates the quartz from the gangue.

"A few yards up the hill another cutting has been put in with the object of following a vein running N. 65° E. The matrix of the vein is similar to that above described.

"Near the head of the gully an open work shows a wedge-shaped mass of quartz and chlorite trending due east. Both walls are granite, the faces of which are often coated with the green carbonate of copper. Some very large crystals of cassiterite could be seen in the quartz lying near the surface.

"Still further up the creek a shallow shaft has been sunk upon a vein which has a course of N. 30° E. The vein has a thickness of from 1 to 12 inches. Hämatite, limonite, and iron pyrites occur associated with the quartz and tin.

"The 60-acre lease lies some distance west of the last. Upon it a shaft has been sunk to a depth unknown to my informant.

"In the shaft a leader with a general course of north-east and south-west is met with.

"Where the shaft now stands a good bunch of tin-bearing gangue, about 2 feet 6 inches across, has been met with. The gangue is quartzose chlorite of a nature similar to that met with throughout the district.

"West of the shaft an open work shows a good leader of variable thickness underlying to the north and trending east and west. The open work, 20 feet in depth and now full of water, is reputed to have yielded a fair quantity of tin ore.

"The only returns of the output of the tin ore from this field are scattered through the annual reports of the Mines Department and the records kept in the Custom House, Dungeness.

"The following is a Tabulated Statement of the Yield of Tin from the Kangaroo Hills District, so far as can be obtained. This table includes the yield from the recently discovered alluvial field in Dingo Creek, distant about 30 miles from Kangaroo Hills:—

Year.	Yield of Black Tin.	Value.	Authority.
	Tons cwt.	£	
1885	100 0	5,556	Mineral Wealth of Queensland.
1886	121 0	6,534	Annual Report, Mines Department, 1886.
1887	83 6	...	Customs Records, Dungeness.
1888	117 16	...	" " "
1889	137 0	...	" " "
1890	38 0	...	" " "

"*Bismuth.*—Fragments of carbonate of bismuth have been discovered in the alluvial gravels in the neighbourhood of Kangaroo Hills. Recently bismuth has been met with in one of the creeks draining into Halifax Bay.

"*Iron.*—Ores of iron are very plentiful throughout the district.

"In one of the branches of Biscuit Creek, about 9 miles down the river below Kangaroo Hills Station, there is a large lode of hæmatite in quartz country. The ore has a considerable disturbing effect on the magnetic needle.

"Some distance north of Donnybrook there occurs what is known as the Iron Mountain. This rises to an altitude by aneroid of 200 feet above the level of the camp at Donnybrook.

"The Iron Mountain in reality occupies one end of the cap of a lode which can be traced for some distance.

"In places there is a kind of quartzose gangue. At one spot huge blocks of hæmatite and limonite stand out in bold relief upon the back of the lode.

"The general course of this lode is north-west and south-east. Numerous veinlets branch off at right angles to the strike. At one place merely small bunches and veinlets of hæmatite occur in the gangue, in addition to small quantities of the blue and green carbonates of copper.

"Near the 'Mountain' the lode or mass presents a steep escarpment to the east.

"On the face green and blue carbonates of copper form botryoidal and stalactitic masses in a cavern about 9 feet in height, which runs for a few feet westwards.

"Along the whole course of the lode a little surface-work has been done, and this seemed to show that the general character of the ore is the same throughout its whole length. The linear persistence of this lode is most marked."

#### "SILVER-LEAD.

"A promising deposit occurs about 25 miles distant southwards from Kangaroo Hill Station at a place known as Donnybrook, on the waters of the Running River.

"The discovery is said to have been made by Mr. R. Moss, one of the present owners, when out on a prospecting trip in the year 1871, but until the year 1890 he took no steps to work the deposit.

"At the time I visited Donnybrook, in June of 1890, Mr. Moss was the only one in the field. Little or no work could be said to have been done; hence to examine the surface features was all that could be done. The deposit occurs amongst a series of quartzites and saccharine limestones, the age of which, in the absence of detailed mapping or fossil evidence, I would hesitate to fix. From such an examination as was made, the limestones did not appear to occupy any very great extent of country, and the whole of the rocks appeared to have undergone a certain amount of faulting and disturbance, resulting in the production of fissures of variable dimensions in which the ores were deposited.

"About half-a-mile north of the camp at Donnybrook a shaft has been put down to no great depth upon a lode of galena of variable thickness. The hanging-wall is well-defined, while the foot-wall cannot be said to have yet been found. A greyish-blue limestone forms the hanging-wall. The course of the lode appears to be about N. 20° E. In the cap were a little green and blue carbonate of copper and cerussite, with kernels of galena. The lead is said to assay about 5½ oz. of silver to the ton.

"A little to the north a similar galena lode had been opened up; this is said to assay 26 oz. of silver to the ton. Very little work had been done at the time of my visit. The ore at the surface contains green and blue carbonates of copper, galena, and carbonate of lead. One of the walls is a white saccharine limestone which runs N. 65° E.

"Close to Donnybrook, the most work appears to have been done upon a lode known as the Hidden Treasure. A shaft has been put down to a depth of 40 feet. No foot-wall appeared to have yet been met with.

"The lode consisted of a large body of kaolin and lithomarge, containing small quantities of green carbonate of copper, some showing native silver fairly abundantly, and a little oxide of manganese (hausmannite?). A specimen from the surface, containing cerussite and copper carbonates, assayed for me by Messrs. Coane and Clarke, yielded 314 oz. 5 dwt. 1 gr. of silver to the ton and 19 per cent. of lead.

"At the foot of the shaft galena was beginning to make its appearance at 45° to N. 60° E. The galena, of fairly fine grain, yielded, on assay by Messrs. Coane and Clarke, 1 oz. 0 dwt. 0 gr. of silver to the ton and 28 per cent. of lead, with a trace of gold."

Since Mr. Maitland's report was written it appears that the Running Creek Silver Mines are about to become of considerable importance.

#### YIELD OF RUNNING CREEK TIN MINES FROM 1883.

1883	...	...	...	25	tons of stream tin, value	...	£1,000
1884	...	...	...	27	" " " "	...	1,134
1885	...	...	...	6	" " " "	...	225
1886	...	...	...	6	" " " "	...	330
Total ... ..							£2,689

In succeeding years the returns do not admit of the separation of the output of Running Creek from that of Kangaroo Hills.

#### ANNAN AND BLOOMFIELD TIN FIELDS.

These tinfields are comparatively new, and till very recently the only ore exported has been stream tin, which is found in narrow gullies among tropical jungle. Fortunately water is abundant, and washing presents no difficulties. The narrowness of the gullies hitherto worked has made it not worth while to apply hydraulic power to the washing, but this will probably be done in future in the wider and deeper drifts of



the lower reaches of the Annan, Trevethan Creek, and the Bloomfield, where large deposits may be expected to occur. The quantities of ore raised, according to the Annual Reports of the Department of Mines, have been as follow:—

		Tons.		Value.
1885	...	300	...	£3,144
1886	...	148	...	7,400
1887	...	945	...	58,783
1888	...	1,051	...	66,949
1889	...	690	...	38,000
1890	...	578	...	34,979
Totals		3,712	...	£209,255

The greater part of the above must have been stream tin. From May, 1889, to May, 1890, 540 tons of stone were crushed at the Lion's Den Machine, yielding 49 tons of "black tin." The only other machine on the field, that at Mount Browning, only commenced work during the present year (1891).

The principal lodes occurring in granite or syenite country are the Mount Leswell, Wheal Davey, Collingwood, Lease 96, Cahill Brothers' Lease, Richmond, Lion's Den, Mount Hartley, Mount Amos, Mount Browning, Fiery Star, Murray and McArdle's, Gladstone, and Creighton's, while Dodd's Lode and a few others occur in a greywacke rock which may be supposed, like the strata of the Palmer Gold Field, to belong to the Gympie Formation.

The ore appears to occur in the lodes for the most part in pipes or shoots, associated with quartz, wolfram, and tourmaline, the last sometimes in considerable quantities,\* and is occasionally very rich.

These mines are described in detail in the two reports by the writer.†

#### CHARTERS TOWERS GOLD FIELD.

See Chapter III.

#### RAVENSWOOD GOLD FIELD.

The country-rock of this goldfield is a grey syenitic granite, in which hornblende accompanies or takes the place of mica. Actinolite is sometimes substituted for the hornblende. The reefs belong to two distinct systems, one running north and south and underlying to the east, and the other running east and west and underlying to the south. They generally have a quartzose gangue, and contain iron and copper pyrites, arsenical pyrites, zinc-blende, galena, &c., as well as gold. This complex "mundic," when exposed to alternate atmospheric and aqueous influences, is decomposed, the metallic compounds being oxidised and the gold set free, and consequently the field was a favourite "poor man's diggings" till the water level was reached. At that level, however, the majority of the mines suffered a severe check, as it was found to be impossible to save more than a small proportion of the gold by amalgamation. The products of some of the richer mines were for a time sent to Europe for treatment, but many of the others which had paid well in the "brownstone" did not produce a sufficient quantity of rich ore to yield a profit after paying expenses, of which the carriage to the coast formed the heaviest item. Roasting was also resorted to, and was successful in some cases. Smelting was next tried, but proved too costly. Chlorination and the "Cyanide" process have also been tested. Improvements in these processes will probably ere long prove equal to the extraction of the gold from what has hitherto been found an unusually refractory ore, when Ravenswood will take high rank among Australian goldfields.

\* See Mr. Clarke's Petrographical Notes.

† Geological Observations on the North of Queensland, 1887; and Second Report on the Tin Mines near Cooktown, 1891.

A considerable quantity of alluvial gold has been obtained in Elphinstone Creek and other streams on the field, mainly by Chinese, who turn over the wash again and again. Alluvial and reef gold have, however, not been distinguished in the early returns, and in more recent years part of the gold in the alluvial may have been derived from tailings.

#### YIELD OF RAVENSWOOD GOLD FIELD.

Year.	REEF GOLD.		Alluvial, &c., Gold.	Total Gold.	Remarks.
	Tons of Stone Crushed.	Oz. Gold.			
To end of—			Oz.	Oz.	
1875	...	...	...	170,649	Deduced from figures in Report Department of Mines for 1884, p. 10
1876	...	...	...	18,788	Includes gold from pyrites and tailings
1877	10,441	11,963 <sup>1</sup>	...	11,963	
1878	15,500	13,252 <sup>1</sup>	...	13,252	<sup>1</sup> Includes gold from pyrites and tailings
1879	15,700	15,744 <sup>1</sup>	...	15,744	
1880	13,479	12,620 <sup>1</sup>	825	13,445	
1881	10,880	8,600 <sup>2</sup>	2,595 <sup>2</sup>	10,195	<sup>2</sup> Includes gold from tailings
1882	7,854	5,002	3,709 <sup>2</sup>	8,711	
1883	7,985	6,054	6,946	13,000	<sup>3</sup> Includes gold from exported mundic
1884	13,202	11,828	2,364 <sup>2</sup>	14,192	
1885	11,039	15,916	1,725 <sup>2</sup>	17,641	
1886	4,706	7,406	1,839 <sup>2</sup>	9,245	<sup>4</sup> Includes alluvial gold and gold from tailings and exported mundic
1887	6,589	6,842	3,548 <sup>2</sup>	10,390	
1888	11,560	8,875	1,791 <sup>2</sup>	10,666	
1889	19,498	14,600	1,119	15,719	
1890	17,796	14,731	1,322	16,053	<sup>5</sup> Classed as "alluvial" by warden
		Total ...	...	369,653	

#### RAVENSWOOD SILVER FIELD.

A belt of argentiferous rocks extends for about six miles north-westward from the richest part of the Ravenswood Gold Field. Although the goldfield and the silverfield are both in granite country, a tolerably distinct line may be drawn between the grey syenitic granite of the goldfield and the coarse-grained red granite of the silverfield. The latter is a mixture of roundish blebs of quartz, flesh-coloured or pinkish orthoclase crystals, and hexagonal mica. The principal lode, known as King's, or the One-Mile, runs N. 28° W., and underlies at 35° to E. 28° N. It is a very rich lode, and frequently consists of two parallel veins. The surface yielded carbonates of lead, giving as much as 300 oz. of silver to the ton. The lower levels have given a steady yield of galena ores, with, as a rule, 2 oz. of silver per ton to the unit of lead. The galena is in places a good deal mixed with pyrites and zinc-blende. In a shaft in Lease 109 the lode has been cut at a vertical depth of 650 feet. The shaft bottomed on an antimony and copper ore, somewhat resembling tetrahedrite in its composition, but containing from 500 oz. to 5,000 oz. of silver to the ton. Pumping and winding and dressing machinery were erected to work this rich deposit, which, however, appears to have thinned out.

The Mount Right Lodes, at the north-western end of the argentiferous belt, have not yet been worked on a large scale, although the Warden reported that in 1883 a single miner raised 20 tons of galena ore, worth £400. In 1884 the same "hatter" raised 26 tons, worth £702. Some thin lodes of antimony ore occur among the silver-lead mines of Mount Right.

In the following table, the great bulk of the ore has been raised from King's Mine. The other mines are specified where the information is given in the Annual Reports of the Department of Mines.

YIELD OF RAVENSWOOD SILVER FIELD.

Year.	Mine.	Tons of Ore.	Raised, Exported, or Dressed.	Value.		
				£	s.	d.
1880	43 Mount Right ...	12½	Exported	371	5	0
"	44 ...	2½	"	86	1	3
"	One-Mile (King's?) ...	108	"	3,152	10	0
1881	King's ...	357	"	14,040	0	0
"	Roberts and Others ...	20	"	1,400	0	0
1882	...	200½	"	6,762	0	0
1883	...	381	"	12,072	0	0
1884	...	895	"	20,560	0	0
1885	...	906	"	22,937	0	0
1886	...	928	Dressed	23,114	0	0
1887	...	1,142	Raised	25,520	0	0
1888	...	11	...	140	0	0
1889	...	...	...	...	...	...
1890	King's ...	274½	Raised	6,411	17	6
	Totals ...	5,291½	...	136,566	13	9

## SELLHEIM BISMUTH MINES.

Three miles east of the township of Eukalunda, on the north side of the Mount Wyatt and Bowen road, is the Daisy Bismuth Mine. The cap is traceable for one chain E. 20° N. to a shaft 12 feet deep. In the shaft the lode is at least 3 feet 4 inches wide, for neither hanging nor foot wall is seen. It has an 8-inch vein of iron and copper ore with greenish-yellow imperfect prismatic crystals of bismuth ore. The vein underlies at a high angle to S. 20° E. Horizontal veins of ore go into both sides of the shaft. The matrix of the ore is mainly red iron oxide with a considerable proportion of "tile ore," or ferruginous red oxide of copper. It contains some green and blue carbonate of copper, sometimes in crystals, and a considerable quantity of the bismuth ore already mentioned. The greenish-yellow crystals yield bismuth, copper, and iron, the bismuth and copper being in the condition of carbonates. It is probable that the ore results from the transmutation of wittichenite or cupreous sulphate of bismuth, which will probably take its place (mixed with iron and copper pyrites) below the water level. It may be mentioned that wittichenite is steel-grey to white in colour, has a black streak, tarnishes pale lead-grey, and contains about 48 per cent. of bismuth and about 83 per cent. of copper. A sample of the greenish-yellow bismuth ore freed from the matrix gave me on analysis 33·76 per cent. of bismuth.

A hole just being sunk 100 yards to E. 20° N. shows ore 2 feet 8 inches in width, mostly iron, manganese, and copper oxides, with some green copper carbonate, and some lumps of yellow bismuth ochre. Another pothole, one chain further along the cap, shows specks of galena, and heavy iron, copper, and manganese oxides. It was opened some years ago by prospectors for silver. The country-rock is syenite.

Half-a-mile east of the Daisy is the Eukalunda Bismuth Mine. It commences at the south-west end with a very large blow (say 12 feet wide) of red ironstone, with some manganese oxide, quartz, and streaks and spots of greenish-yellow bismuth ore. A hole 12 feet deep shows it to underlie at a high angle to the south-east. A shaft 20 feet deep about 40 feet to the north-east shows the same underlie, but does not prove the width of the lode. The shaft shows ferruginous quartz with some bismuth ochre,

traversed by horizontal yellow clay veins. One chain further north-east a shaft 40 feet deep shows the underlie of the lode to be 80°. The ore is to a large extent composed of yellow oxides of bismuth and iron, red iron oxide, some copper pyrites, and large quantities of greenish-yellow bismuth ore. The lode is at least 5 feet wide, but the hanging-wall is not seen in the shaft. There are two veins of ore, each about 10 inches thick, and veins of ironstone run towards the hanging-wall side of the shaft at an angle of 45°. For about 3 chains north-east of the 40-feet shaft the greenish-yellow bismuth ore is traceable in the cap of the lode. For 7 chains further only ironstone is seen.\*

The Reports of the Department of Mines show the output for the last two years to be as follows, the mines having as yet been only worked on an experimental scale, owing, I believe, to the difficulty in getting access to the bismuth market:—

			Ore Raised. Tons.		Estimated Value.
1889	...	...	44	...	£8,300
1890	...	...	6	...	681

#### CROYDON GOLD FIELD.

This goldfield was only discovered in the end of 1884, and for some time its importance was not recognised. After some extraordinary crushings of Croydon stone at the Etheridge the first machine was opened on the field in November, 1886, and since then the prosperity of the place has advanced rapidly. The population was estimated at 8,000 in December, 1887, and (by the Warden) at 3,212 in December, 1889; the floating population attracted by the first rush having been reduced to the number necessary for the industry. The township is now connected by rail with Normanton.

The part of the field immediately surrounding the township lies in a hornblendic granite, but north and east of the town is a wide-spread rock, apparently of metamorphic origin. It has a flinty ground-mass, and shows at one end of the series a clastic structure like an altered conglomerate, and at the other fluxion-structure.† Many of the reefs lie rather flat, and this circumstance gave rise at first to misgivings as to their permanency; but this prejudice, like many others, has had to yield to the logic of facts. In some the gold is very much alloyed with silver. One line of reef shows a good deal of native silver.

The township is on the very edge of an alluvial flat which extends to the Gulf of Carpentaria. Of some of the deposits in this flat it is impossible to say whether they are recent alluvial "cements" or belong to the Desert Sandstone. The auriferous rocks themselves nowhere rise to any considerable elevation, and are overlaid in places by isolated fragments of fossiliferous Desert Sandstone, which are alluded to in another place.

Besides the township of Croydon proper, Carron, Golden Valley, Tabletop, Goldstone, The Homeward Bound, The Mark Twain, The Croydon King, The Springs, and Wallabadah are centres of mining industry in the neighbourhood.

#### YIELD OF CROYDON GOLD FIELD.

Year.	Stone Crushed.	Yield therefrom.	Alluvial Gold.	Total Gold.	Average Value of Gold per oz.
	Tons.	Oz.		Oz.	
1887	10,950	31,787	(Not estimated)	31,787	£2 13 6 (Local value)
1888	22,792	44,839	23 oz.	44,862	£2 17 3½ (Mint value)
1889	29,439	52,541	(Not estimated)	52,541	£2 11 4½ (Local value)
1890	43,226	60,368	(Not estimated)	60,368	£2 13 3 (Local value)
		Total ...	...	189,558	

\* Report by R.L.J. on the Sellheim Silver Mines and Surrounding District. Brisbane: Authority: 1889.

† See Mr. Clarke's Notes.

## ETHERIDGE GOLD FIELD.

The greater part of this extensive field is a coarse-grained granite with large crystals of orthoclase felspar and flakes of mica.\* Of this granite Mr. Daintree remarks† that it is simply transmuted mica schist, as shown by the presence of occasional bands of unaltered schist throughout the mass. The principal drawbacks to the field hitherto have been its inaccessibility and the isolated position of the reefs. Mines, without an output sufficiently large to keep their own crushing machinery going, have again and again been abandoned owing to the cost of carriage to the nearest mill. The principal centres of mining are the Cumberland, Durham, Georgetown, Finnegan's, and Goldsmith's.

The Cumberland Mine, which has been one of the most productive on the field, has an elvan dyke between the walls, the reef sometimes occupying its upper and sometimes its lower side. The quartz reefs, except above the water level, are generally charged with iron pyrites, copper pyrites, arsenical pyrites, zinc-blende, and galena, in varying quantities. The mines at Goldsmith's form, geologically, part of the Gilbert Gold Field, being situated in mica-schist country, although geographically they belong to the Etheridge Basin. The stone from these mines is less difficult to treat than that from the reefs in the granite.

The Etheridge and Gilbert having been, during the greater part of their history, in charge of the same Warden, the returns from these fields have been generally lumped together. This is unfortunate for statistical purposes, as the two fields are geologically distinct. In the following table the greater part of the reef gold must have come from the Etheridge, and the greater part of the alluvial gold from the Gilbert. In 1881 and 1882 the return also includes gold from the Woolgar. The amount from the Woolgar in 1881 must have been trifling, as the Warden at the end of the year reported that the crushing machinery was only "nearly ready." In 1882 the amount from the Woolgar was probably about 2,000 oz.

YIELD OF ETHERIDGE GOLD FIELD.

Year.	Stone Crushed.	Yield therefrom.	Alluvial Gold.	Total.
To end of—	Tons.	Oz.	Oz.	Oz.
1875	...	...	...	‡ 129,798
1876	...	...	...	13,202
1877	3,134	4,837	...	4,837
1878	3,550	6,365	1,031	7,396
1879	4,417	5,927	9,571 ?	15,498
1880	4,455	8,821	11,547	20,368
1881	12,151	20,926	2,104	23,030
1882	7,428	13,190	5,241	18,431
1883	10,751	16,127	2,840	18,967
1884	7,010	16,560	1,000	17,560
1885	11,354	22,708	...	22,708
1886	10,983	22,700	500	23,200
1887	8,100	24,603	50	24,653
1888	§ 8,606	§ 22,662	...	22,662
1889	11,083	18,150	...	18,150
1890	18,575	24,310	270	24,580
		Total ...	...	405,040

\* See Mr. Clarke's Notes.

† General Report upon the Northern District. Brisbane : by Authority : 1870.

‡ Deduced from figures in Report of the Department of Mines for 1884, p. 11.

§ Including Woolgar, but excluding Mount Hogan, which is added to Gilbert returns.

|| Including Woolgar, Mount Hogan, and Gilbert. At these places little appears to have been done.

## EIDSVOLD GOLD FIELD.

"The country-rock round about Eidsvold consists of granite, which for the most part is medium-grained, of a pinkish-brown colour. Its constituents are orthoclase felspar, largish blebs of quartz, and small crystals of mica (biotite). The rock passes in parts into a fine-grained syenitic granite of a darkish colour, and contains hornblende in addition to mica.

"The reefs are situated in the granite country. They are running in various directions, though the majority of them have a north-west to north-north-west bearing. They lie very flatly in most cases, the underlie varying from  $45^{\circ}$  to  $75^{\circ}$ .

"All the reefs contain a certain amount of mundic; and, as the water level has not yet been reached, the quartz is often of an ochreous or gossany nature from the decomposition of the sulphurets. It is probable that the reefs will be rich in sulphurets at a depth.

"Eidsvold, in many respects, somewhat resembles the Charters Towers Gold Field. The chief points of resemblance are—the country-rock, which in both places consists to a great extent of granite and syenite or syenitic granite; in the flat underlie of the reefs; and in the character of the gangue of the reefs, which consists in both places, to a great extent, of decomposed granite débris with veins of quartz.

"Comparatively small amounts of the sulphurets (pyrites and galena, &c.) have yet been met with in the Eidsvold reefs, owing, no doubt, to the fact that the workings have not yet reached beyond the action of atmospheric influences. The quartz, however, is often ferruginous, and contains a yellow ochreous material which has been produced by the decomposition of these sulphurets, which will be found to exist in large quantities in the reefs when the water level is reached. A few of the reefs contain a good percentage of galena, a mineral of very common occurrence in the Charters Towers reefs. Very little copper ore occurs in the reefs. On the other hand, arsenical pyrites is of common occurrence here in some reefs. I did not meet with any zinc ore at Eidsvold, while sphalerite (zinc-blende) is of common occurrence at the Towers.

"The field, as far as can be gathered from surface indications, is, with the exception of a few porphyry and syenite dykes, singularly free from eruptive dykes.

"So far as can be judged from the work already done, the prospects of Eidsvold as a reefing district are very good.

"The field will soon have the advantage of a thorough trial, for two or three batteries will soon be on the field." (*Report on the Eidsvold Gold Field*, by William H. Rands, Assistant Government Geologist.)

In the report above quoted, Mr. Rands gives detailed descriptions of the several reefs, and mentions the occurrence of tin ore (cassiterite) in one of them, associated with tourmaline, and of stibnite (sulphide of antimony) in another.

## YIELD OF EIDSVOLD GOLD FIELD.

Year.	REEF GOLD.		Alluvial Gold.	Total Gold.
	Stone Crushed.	Gold therefrom.		
	Tons.	Oz.	Oz.	Oz.
1887 ... ..	27	84	...	84
1888 ... ..	7,768	6,907	100	7,007
1889 ... ..	15,933	15,446	150	15,596
1890 ... ..	20,910	15,823	110	15,933
Totals ... ..	44,638	38,260	360	38,620

## MOUNT PERRY COPPER MINE.

Although this is not the only copper-mine in the district, it is the only one which has been worked continuously and on a large scale.

Mr. Israel Bennett, Inspector of Mines, and formerly manager at Mount Perry, was good enough to give me the following notes in 1885:—

"Seven shafts have been put down on the lode to various depths; the main or engine shaft is now between 800 and 900 feet deep. The course of the lode is N. 37° E., and where it is at present being worked (to the south-west of the main shaft) it hades to the south-east about 8°" [from the vertical]. "Near the surface the ore consisted of green carbonate and azurite, and at 30 feet deep of rich red (cuprite) and grey oxides of copper, and below this depth of yellow ore and copper pyrites. The pyrites is contained in a veinstone of quartz and calcite, each of which predominates in turns. To the north of the main shaft much iron pyrites has been met with mixed with the copper ore. At the present depth [1885] the lode is about 4 feet in width. The width of ore is about 10 inches on an average." . . . "There are numerous cross-courses, which, although they do not displace the lode, yet often affect the ore in the lode, either by breaking it up into strings, or by displacing it from one side of the lode to the other. At these points of intersection the lode is usually enriched. A dyke of orthoclase porphyry runs parallel with the lode, and is displaced, too, by the cross-courses. Two dykes of dolerite also cross the lode in a north-westerly direction."

The country-rock is a syenitic granite which Mr. Rands regards as metamorphic. The granite in places has carbonate of copper disseminated through its mass. At the Queensland Claim, the granite is worked as a low-percentage ore (10 per cent. of copper) to assist in the smelting of the pyrites at the Mount Perry Mine.

The output of the mine prior to 1885, according to Mr. Bennett, was—

95 tons ore at £20	...	...	...	£1,900	Os.
19½ "	£10	...	...	197	10s.
1,200 tons copper at £70	...	...	...	84,000	Os.
Total				£86,097	10s.

In 1888 the Annual Report of the Department of Mines shows 1,096 tons of copper ore, valued at £9,128, and in 1889, 978 tons of copper ore, valued at £10,000, from the Tenningering District. This was probably for the most part the product of the Mount Perry Mine. In 1890 the amount of copper raised in the Tenningering District was 85 tons, valued at £1,000, and the Mineral Lands Commissioner reports the Mount Perry Mine to have been closed.

The Canterbury and Normanby Lodes adjoin and run parallel with the Mount Perry Lode. Nine miles to the west is the Potosi Lode. It contains galena, with copper and iron pyrites and a little zinc-blende, in a gangue of quartz and barytes. The Mungai Lodes are three miles further west, in a country-rock of actinolite schist. From these lodes carbonates of copper are raised for smelting with the Mount Perry ores.

The Wolca Lodes are six miles north of Mount Perry. Some of these contain gold, one (the Allendale) as much as 15 dwt. to the ton, as well as copper ore. There is another group of lodes in the paddock of Wombah Station.

The Boolboonda Mines lie to the east of the granite country, in a belt of metamorphic rocks, consisting of gneisses, schists, quartzites, &c. The Boolboonda, Cambria, and New Moonta Lodes contain gold as well as copper—apparently in several cases in proportions which would be payable under favourable conditions.\*

\* For further details see Mr. Rands' Report on the Gold Fields of Raglan, &c., and the Mineral Deposits in the Burnett District. Brisbane: by Authority: 1885.

## TENNINGERING, BOOLBOONDA, MOLANGUL, AND NORMANBY GOLD FIELDS.

The Reid's Creek reefs are about five miles south-south-west of Mount Perry, on Branch Creek, a tributary of Reid's Creek. These reefs, Mr. Israel Bennett, Inspector of Mines, informs me, have turned out, up to 1886 (I gather from the Annual Reports of the Department that they have only been worked since 1881), 400 tons of stone, valued at £15 per ton, £6,000, and 1,200 oz. of gold, valued at £3 10s. per oz., £4,200; total, £10,200. At a depth the lodes yield a mundic consisting chiefly of arsenical iron pyrites, but containing also iron pyrites and zinc-blende, with here and there blocks of galena.

None of the other smaller fields in the Burnett District have ever attained to much importance, and it would be impossible to estimate their yield with any degree of accuracy. They are grouped together in the official returns, sometimes under one heading and sometimes under another. The little field which produced all the gold in one year's return was perhaps abandoned the next, so that the gold-mines of the whole Burnett District have to be regarded as one group. Probably even thus the returns are unsatisfactory. For instance, Mr. Rands in his Report, published in 1885, gives the output for 1884 of the Reid's Creek mines *alone* as 688 oz. of gold from 830 tons of stone, while the output of the whole district for the year is given in the Annual Report of the Department of Mines as 431 oz. from 603 tons.

## YIELD OF TENNINGERING AND OTHER SMALL GOLDFIELDS IN BURNETT DISTRICT.

Year.	Stone Crushed.		Gold therefrom.		Total Gold.
	Tons.		Oz.		Oz.
1880 ... ..	...		...		63
1881 ... ..	1,809		1,254		1,254
1882 ... ..	889		622		622
1883 ... ..	355		376		376
1884 ... ..	603		431		431
1885 ... ..	127		92		92
1886 ... ..	1,066		90		90
1887 ... ..	1,398		671		671
1888 ... ..	2,428		1,553		1,553
1889 ... ..	2,065		1,246		1,246
1890 ... ..	2,341		1,901		1,901
			Total ... ..		8,299

## JIMNA AND GOOROOMJAM GOLD FIELDS.

Jimna Gold Field has been worked off and on for more than twenty years, but has not been highly productive, except at first, for alluvial gold. Its output, when reported, has generally been massed in the annual returns with those of "Other Small Fields."

The rocks at the Jimna Diggings are principally granite, slate, and sandstone, with comparatively little quartz. The alluvial drift of the only two creeks that have been worked—Jimna and Sandy Creeks—rests sometimes on decomposed granite and sometimes on sandstone or slate. The workings have extended four or five miles down each of these creeks. Mortimore's reef, on Jimna Creek, contains fine gold. It is interesting as having been the first auriferous reef observed in the colonies traversing granite country.



## CHAPTER III.

### METAMORPHIC ROCKS (SLATES, SCHISTS, GNEISSES, &c.) OF UNDETERMINED AGE.

**Mineral Areas—viz., Cloncurry Gold and Copper Fields, McKinlay Gold Field, Charters Towers and Cape Gold Fields, Gilbert and Woolgar Gold Fields, Coen Gold Field, Normanby and Marengo Gold Fields, Peak Downs Gold Field, Peak Downs Copper Field.**

ALTHOUGH the area of metamorphic rocks, of which the age had not been determined when I issued my Geological Map of the Colony in 1886, has been considerably reduced in the present edition, it will be seen that a considerable area still remains.

In 1872 Mr. R. Etheridge, F.R.S., stated\* that the Broken River limestones (Middle Devonian), which he called "Siluro-Devonian," were the lowest fossiliferous rocks in Queensland. The late Rev. W. B. Clarke (I think, erroneously) ascribed to Mr. Etheridge the view that "nothing lower than Siluro-Devonian rock has been found in Queensland." No older *fossils* have yet been discovered, but lower and older stratified rocks certainly exist.

The granites and syenites of Charters Towers appear to be the ultimate stage in the metamorphism of the series of stratified rocks described in my Report "On the Geology and Mineral Resources of the District between Charters Towers Gold Field and the Coast."†

These rocks are older than the Burdekin Beds. They are all metamorphosed in a greater or less degree. The metamorphism must have taken place prior to the deposition of the Burdekin Beds, pebbles and granules of the metamorphosed rocks forming the material of which the conglomerates of the latter series are built up.

These once horizontal beds are now thrown into broad folds, and probably do not occupy more than one-fourth of the surface over which they were deposited. The stratified rocks occur to the north and west of Charters Towers. They consist of quartzites, slates, and shales. The slates do not differ from the shales in mineral composition—mainly silicate of alumina, with a high percentage of peroxide of iron—but simply in being intersected by cleavage planes. Both the slates and the greywackes are, as a rule, highly impregnated with iron, being in places "iron-masked" to such a degree that they might almost be taken for weathered clay-band ironstones. Occasionally, where the greywackes are fresh and contain little iron, they somewhat resemble blue limestone, while their joint-surfaces are often coated with calc-spar. A conglomerate of small quartz-pebbles, enclosed in a matrix of fine sandstone (mainly of felspathic materials), coloured dark red with peroxide of iron, is met with in two places between Charters Towers and the Burdekin. In these stratified rocks no fossils have as yet been detected.

Again, in the valley of the Reid, the Middle Devonian limestones rest unconformably on greywackes, &c., which are probably of the same age as the stratified rocks west of Charters Towers, and have interstratified with them some thick beds of brecciated volcanic ash.

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\* Quart. Journ. Geol. Soc., vol. xxviii., p. 384.

† Brisbane: by Authority: 1879 p. 15.

In the neighbourhood of Clermont a series of gold and copper-bearing schists, slates, quartzites, &c., is apparently overlaid unconformably by a bed of limestone of Devonian age. \*

In many other localities, stratified rocks, belonging to formations newer than the Devonian, rest unconformably on upturned strata which are more or less metamorphosed, but, beyond the superposition of the newer formations referred to, there is nothing to indicate the age of the upturned rocks in the absence of palæontological evidence.

The whole of the strata classed as "undetermined," consisting originally of limestones, conglomerates, siliceous and felspathic sandstones, clay shales and mudstones, are generally thrown into sharp folds, and are often locally metamorphosed into marbles, quartzites, greywackes, mica- and talc-schists, lydian stone, &c.; or, still further, to the utter obliteration of their originally stratified character, into serpentines, diorites, hornblende- and tourmaline-gneisses, porphyries, granites, &c.

In succeeding chapters it will be seen that Daintree and other geologists ascribed large areas of these metamorphic rocks to the Silurian and Devonian, chiefly on the ground of their lithological resemblance to the strata of these formations as developed in Victoria and New South Wales. In regions so far distant I cannot attach any importance whatever to evidence of this nature.

It is impossible to hazard even a guess as to the total thickness of the metamorphosed strata on which "no name" has been inscribed. Mr. Rands estimates† the thickness of the metamorphic schists and quartzites of the Cape Gold Field alone at from five and a-half to six miles.

It is to be hoped that all the rocks now mapped as "of undetermined age" will be relegated to their proper horizons by future observers, and it is more than likely that the greater portion will be distributed between the Permo-Carboniferous and Devonian. Possibly representatives of some of the older Palæozoic formations which, so far as we know, are absent from Queensland, may yet be detected among the more or less metamorphosed strata. It may be suspected that the limited areas of metamorphic rocks in the south-western corner of the Colony are a prolongation of the Cambrian rocks of South Australia and the north-western portion of New South Wales.‡

We have not as yet been able to recognise in Queensland by direct evidence any equivalents for the Cambrian of Yorke's Peninsula, South Australia, nor for the Graptolite-schists of Victoria, nor for the Upper Silurian limestones of Yass and Bowning, New South Wales, and of Lancefield, &c., and the Upper Yarra Basin in Victoria.

It would be beyond the scope of this work to attempt to give a detailed description of the metamorphic rocks of Queensland. Such descriptions will be found in overwhelming detail in the voluminous writings of Stutchbury, Aplin, Daintree, Gregory, and the officers of the present Geological Survey.

## MINES IN CONNECTION WITH METAMORPHIC ROCKS OF UNDETERMINED AGE.

### CLONCURRY GOLD AND COPPER FIELDS AND MCKINLAY GOLD FIELD.

The greater part of this extensive area is covered by highly inclined slates, quartzites, and greywackes, with occasionally a bed of limestone. These have so far proved unfossiliferous, and there is no distinct evidence of their age. These rocks form,

\* Report on the Geology and Mineral Deposits of the Country in the Vicinity of Clermont. W. H. Rands. Brisbane: by Authority: 1886. See also Chapter VIII.

† Report on the Cape River Gold Field. Brisbane: by Authority: 1891.

‡ Is it possible that some of these beds of undetermined age may also represent the Azoic rocks of South Australia, below the Cambrian?—*R.E. junr.*

as it were, a peninsula extending south-eastward from the north-west corner of the Colony, and projecting into the Cretaceous rocks of the Rolling Downs Formation. In the neighbourhood of the Mount Douglas gold-mines the country is studded with rugged knobs of granular quartzite, which may represent the discharge pipes of thermal springs. The field is intersected with enormous siliceous veins like those of the Hodgkinson Gold Field. A few small isolated tablelands of the Desert Sandstone attest the former extension of that formation.

The gold-mines have been worked in a desultory and unsatisfactory manner, for which the position of the field is no doubt in large measure to blame. The Gilded Rose, on Fisher's Creek, in a country-rock of flaggy talcose sandstones and shales, has been most persistently worked. The reef is highly charged with pyrites. The carbonates of copper in the Homeward Bound and Flying Dutchman lodes contain a good deal of gold. In the Uncle Tom, on Pumpkin Gully, the gold is associated with quartz, carbonate of lime, and carbonate of iron. In the Mary Douglas, at the Top Camp, rich deposits of gold, associated with native bismuth, have been obtained from quartz coated with botryoidal and stalagmitic masses of glossy-black limonite. Within the last few weeks, much excitement has been created by the discovery of the Last Call Mine, near the Soldier's Cap (a Desert Sandstone tableland), to which the Goldfield Warden refers as follows, in a Report to the Minister for Mines, published in the *Brisbane Courier* \* :—

"On two occasions I visited the mine and found by careful tests the whole body of conglomerate extremely rich, the prospects I took giving on my first inspection from 5 oz. to 12 oz. from the heap at grass and in the lower workings in bottom of shaft, and in the faces of the drives and crosscuts overhead, and at foot the prospects were really splendid. Assays made from stone taken from a leader running through the great bulk of the deposit gave startling results—far too good to anticipate anything equal in the average of any mine yet found. The main body of this singular deposit is a granular carbonate of lime with a considerable proportion of micaceous sandstone and some oxide of iron (miners' black sand). The largest of the gold consists of fine hair-like threads, not exceeding half-an-inch in length, diminishing in size to the smallest speck of dust. A quantity of specular and red hematite iron ore is also obtained, carrying a large percentage of gold similar in quality to that in the limestone, but the thread filaments are absent. The area of the lease is 6 acres, and although considerable preliminary work has been necessary, such as sinking wells, timbering, road-making, &c., good progress has been made in the mine. The shaft has been sunk 38 feet, and drives put in north and west, and about 100 tons of crushing stuff paddocked. With a view to test the capabilities of their property, the owners purpose sending a few tons to the machine at Soldier's Cap, and probably 2 tons will shortly be in transit to Charters Towers for treatment. Two independent tests from bulk made in Sydney gave over 68 oz. of gold and nearly 8 oz. of silver, and one in Charters Towers, in which no gold was visible, gave 69 oz. gold and nearly 12 oz. silver. From the leader before mentioned 2 lb. weight of stone when reduced yielded 1 oz. of excessively fine gold. The various leases adjoining No. 15 have struck nothing as yet; but at greater depth I consider Nos. 17 and 21, on the south, and No. 18, on the west, the best properties, although it is difficult to predict where the run may extend, as the whole of Martin's Creek formation presents something unique in mining, and is certainly puzzling to the devotees of old mining legends."

The gullies and flats radiating from the Mary Douglas Hill have yielded rich alluvial gold, all heavy and nuggetty, and frequently so coated with iron oxides that the

miners knew it as "black gold." One nugget weighed 28 lb. Alluvial gold, with native bismuth, is extensively distributed in the Pumpkin Gully region, and would pay well to work by hydraulic power, if that could be brought to bear on it.

The total amount of alluvial gold reported since 1877 is 4,751 oz., but it is obvious that the returns are very incomplete. The total amount of reef gold from 1877 to 1890 is 5,283 oz., but, as the amount of stone crushed is not in all cases given, the yield per ton cannot now be estimated.

The McKinlay Gold Field is believed by many to be a promising one, but has not as yet been steadily worked. Several reefs have given good returns for a time, and a considerable quantity of alluvial gold has been won, but no record appears to have been kept. The country-rock is said by Daintree to be of metamorphic rocks (gneiss and mica- and talc-schists). "The associated minerals are gold and copper, the presence of 'dykes' of intrusive material seeming to be the chief cause of mineralisation."\*

#### YIELD OF CLONCURRY GOLD FIELD.

Year.				Stone Crushed.	Yield therefrom.	Alluvial Gold.	Total.
				Tons.	Oz. Gold.	Oz.	Oz.
1877	...	...	...	1,190	1,205	alluvial? 295	1,500
1878	...	...	...	1,014	1,316	...	1,316
1879	...	...	...	209	293	...	293
1880	...	...	...	406	490	...	490
1881	...	...	...	...	no returns	...	...
1882	...	...	...	410	453	...	453
1883	...	...	...	no returns	say 500	say 500	1,000
1884	...	...	...	no returns	no returns	...	...
1885	...	...	...	no returns	50	alluvial? 400	450
1886	...	...	...	80	85	566	651
1887	...	...	...	...	...	1,262	1,262
1888	...	...	...	...	...	402	402
1889	...	...	...	1,600	836	410	1,246
1890	...	...	...	318	55	736	791
					Total ...	...	9,854

The Cloncurry Field contains some very extensive deposits of copper ore. The chief of these are the Great Australian and the Argylla. The copper is in the form of carbonates and red oxides. The latter ore, of which there are enormous deposits, is frequently richer than chemically pure red oxide, being mixed up with native copper. The Great Australian is the only mine which has yet been worked to any extent, and has produced, in 1885-7, 3,250 tons of ore, valued at £33,520.

#### YIELD OF CLONCURRY COPPER FIELD.

1885	...	1,340 tons raised	...	Value, £18,920
1886	...	900 "	...	" 7,000
1887	...	1,010 "	...	" 7,600
Totals	...	3,250 tons	...	£33,520

Argentiferous lead lodes occur on the field, chiefly in the Dugald Valley. One of these, still unworked, is over a mile in length.

The most striking features of the country are mountains of pure specular and magnetic iron ore. One of these—Mount Leviathan—is about two hundred feet high, and a quarter of a mile in diameter at its base. It is singular to reflect that these deposits, which, if they were located in England, would be colossal fortunes for their owners, are at present absolutely valueless owing to their geographical position.

\* General Report upon the Northern District. Brisbane: by Authority: 1870.

## CHARTERS TOWERS AND CAPE GOLD FIELDS.

These goldfields, although both geographically and geologically distinct, are generally grouped together. They have for the greater part of their existence been in the charge of the same Warden, and the returns from each have not always been kept separate. The Cape, although at one time a rich alluvial field, has of late years diminished in relative importance, so that at the present day its output does not seriously affect the total yield of the two fields.

In Daintree's Report on the Cape River Diggings, &c.,\* it is said that payable gold deposits were "confined to the south-eastern outcrops of a vast thickness of schistose rocks developed on the 'Cape'; the north-western extension of the same having failed to yield the precious metal in remunerative quantities to the prospector." The metamorphic schists are divided by him into Upper, Middle, and Lower. The Upper is composed of hard quartzites and silicified mica slates. The Middle consists of soft thin-bedded mica slates, with occasional bands of silicified mica and hornblende schists. In the Lower subdivision, laminated granite, and mica- and hornblende-slates are interstratified; and it is in this portion of the series that transmutation of the schistose rocks is most marked. Indeed, near the junction of the schistose and granite rocks, so great has been the alteration that it is difficult to say where the schists end and the granite commences.

"No fossils have yet been, or are likely to be, met with in these beds on account of their metamorphic character throughout. The only assertion to be made in regard to their age is, that rocks of a similar character further north are unconformably overlaid by others containing abundance of Upper Silurian fossils."†

In the map attached to the Report the metamorphic rocks are provisionally classed as "Lower Silurian." The Report further mentions that where elvan or porphyritic dykes traverse the metamorphic rocks the richest gold deposits were always found. In some cases there was reason to suspect that "the rich quartz veins were a continuation to the surface of the elvan veins themselves."

Mr. Rands, in a recent Report,‡ to which the reader is referred for a description of the various reefs and leads, refers to these schists as follows:—

"The Cape River Gold Field comprises a series of schists and quartzites of vast thickness, extending for a distance of over 50 miles in length, with an average of about 10 miles in width. The schists 'strike' about W.N.W. and E.S.E., and have an average dip of from 30° to 35° to the S.S.W. As there is no sign of folding or repetition of the rocks, the same dip continuing throughout, this would give a thickness of between 5½ to 6 miles of these rocks; nor is this even their entire original thickness, for to the north-north-east their place has been taken by intrusive granite, leaving only here and there traces of the original schists.

"The schists in reality extend to a much greater distance in the direction of their 'strike,' but they are covered with basalt. For instance, just north of Lolworth there are two small hills, 'inliers' of schist, and the same rock crops out at Cargoon Station. The schists of the Woolgar Gold Field are probably a continuation of the same series, separated by a large layer of basalt, and they are probably continuous with the schists of the Gilbert River, separated only by beds of overlying 'Desert Sandstone.' How far in the opposite direction—to the east-south-east—they extend it is impossible to say, as the country is all a large alluvial flat.

\* Brisbane: by Authority: 1868.

† Mr. Daintree probably referred to the Broken River, where rocks of a similar character are overlaid unconformably by a limestone charged with fossils. The fossils, however, turned out to be Devonian.

‡ On the Cape River Gold Field. Brisbane: by Authority: 1891.

"The lower portion of this series of schists—that which extends along the north-north-eastern part of the field, and includes Mount Davenport and the Upper and Lower Cape—consists of mica and hornblende schists into which granite has intruded to such an extent that the area occupied by the granite is greater than that of the original schists. There is also an interbedded and somewhat laminated granite in this portion of the field, which may be due to extreme alteration of the schists.

"Above this is a great thickness of mica schists with thin beds of hornblende schists; these rocks are softer, and have been worn away to a great extent by denudation, leaving large alluvial flats, with here and there small rounded hills of somewhat harder schist, which stand out prominently.

"The highest portion of the series—that extending along the south-south-western portion of the field—consists chiefly of quartzite with hardened schists, which, on account of their hardness, have resisted denudation, and have determined the rough and hilly nature of this part of the field. The long spur, running in an east-south-easterly direction from the main dividing range at Mount Miller to Mount Remarkable, a distance of about 30 miles, is composed almost entirely of quartzite.

"Mr. Daintree, on lithological grounds, divided these beds into three divisions—the Upper, Middle, and Lower. In the absence, however, of any fossil contents—and they are not likely to be met with in rocks so much metamorphosed—and as the deposition of the strata appears to have been continuous throughout, I do not think there is sufficient reason for keeping up these divisions.

"With reference to the age of the schists, I can say nothing more than that they are the oldest rocks of the district, as the granite to the north-north-east does not form the base or bed on which they were originally deposited, as intimated by Daintree, but has since intruded into the schists."

Free gold is found in the alluvia of the present watercourses, generally in the vicinity of rich quartz reefs. But an older fragmentary drift, which Mr. Daintree calls Pliocene, yields gold of a rounded waterworn character, independent of any local source of supply. Several well-defined leads are mentioned, which, "down the Cape so far as the Lower Diggings," and down Running Creek as far as the junction of Golden Gully, may be considered as the representative of old river channels; beyond these points, to the south and east, it can be regarded in no other light than that of accumulated sediment from a vast lake or sea. It has been found in working that where this supposed old watercourse is narrowest the gold is most concentrated; but when it becomes broader and the drift deeper, the gold is found to be too scattered to pay for the additional cost of mining.

Of these Lower Cape Diggings, Mr. Rands (*loc. cit.* p. 6) gives the following further particulars:—

"The Lower Cape, or Capeville as it was formerly called, is situated on the Cape River, about 3 miles above Hawthorn Vale Station. Nearly all the workings at the Lower Cape are on what is known as the 'Deep Lead.' This was worked first about eighteen years ago, and attracted a population of over 3,000; now the population is not over 30, including the Chinamen.

"The lead has been worked in a southerly direction from the river for 2½ miles. The lead is both narrow and shallow; near the river it becomes deeper, and widens out towards the south. Near the surface the drift consists of a decomposed schistose material with pebbles of quartzite, granite, and quartz throughout it. The wash, in which the gold occurred, consists of large rounded pebbles of a glassy-looking white quartz, cemented loosely together by a schistose débris. The wash, as a rule, was from 1 foot to 18 inches, and in places as much as 2 feet, in thickness. The gold was

coarse, and very much waterworn and rounded, of a very different character to the more or less angular particles obtained from the gullies. The washdirt went from 1 oz. to as high as 25 oz. of gold to the load, averaging nearly 3 oz. to the load.

"The most northerly point at which this lead has been worked is about 300 yards south of the river, and about the same distance west of the township. The depth of the drift here was 38 feet; and then it became shallower opposite the township, being only 15 feet deep. Just north of Gahn's Flat the surface is being worked by a sluicing company. The water for sluicing is pumped up from the river flat into tanks by a small engine. The quantity of water was quite insufficient for sluicing on a large enough scale to make it pay. The returns have been very poor, with the exception of a few patches of small nuggets which were met with. The drift spreads out over Gahn's Flat and then crosses a low ridge known as Red Hill. The depth here was only about 3 feet, and the whole of it was worked, yielding about 3 oz. of gold to the load. The drift on this hill is coloured red with oxide of iron. Towards the south of Red Hill it becomes deeper, and is about 15 feet deep. Immediately south of Red Hill is White Hill, where the drift changes quite suddenly to a white colour. From this point it gradually gets thicker, until at a distance of  $2\frac{1}{2}$  miles the shafts are from 90 to 100 feet in depth, and the lead has spread out from a couple of hundred yards to half-a-mile across, the gold here being more disseminated, going only about  $\frac{1}{2}$ -oz. to the load, and the greater depth to which the shafts had to be sunk to bottom caused the lead to be abandoned. Very little prospecting has been done south of this point to ascertain whether a channel exists in which the gold would be more concentrated.

"The late prospecting party which was receiving Government aid simply put down a few holes in close proximity to the old workings at both ends of the lead. To thoroughly prospect it a series of holes, connected with drives, should be put right across the drift some distance in advance of the last working places.

"A few holes were put down near Murray Creek,  $3\frac{1}{2}$  miles south of the township, but without any results.

"In wet seasons, when there is plenty of water about, men make a living fossicking over the old workings. It might pay to sluice the whole ground over if the difficulty of obtaining water could be overcome.

"Large quartz reefs occur in the schists on both sides of the lead. They are composed of a hard, glassy, barren-looking quartz.

"On the northern side of the river, between a point opposite Charters Creek and Sandy Creek, known as Milkman's Point, very rich gold has been obtained in a drift similar to the above, with the exception that granite boulders are more numerous. The drift on this flat is between 40 and 50 feet deep. A large portion of this ground is still unworked on account of the great amount of water met with. Between Rocky and Sandy Creek the wash went 6 oz. of gold to the load. A good deal of surfacing has been done here too.

"A deep drift was worked on the south side of Sandy Creek, opposite Chinaman's Gully, about  $3\frac{1}{2}$  to 4 miles up above its junction with the river.

"As to the age of these drifts it is impossible to say more than that they are considerably older than the alluvial deposits of the present watercourses. It is very probably a Tertiary deposit. It is impossible without a detail survey to define its extent south of Bett's Creek, but much of the country coloured Pliocene Tertiary on Daintree's map is recent alluvium.

"Chinaman's Gully was exceedingly rich throughout its whole length. The bed of the gully is very narrow, and the gold was therefore concentrated in a small space.

The gold was coarse and nuggetty. A large flat nugget of 90 oz. was found by the Chinamen, as well as several others ranging in weight from 2 to 20 oz. The gully was discovered by Chinamen, and has been worked over three successive times by them. The gold is somewhat similar to that got in a drift near the head of the gully, and may have come from there. At the time of my visit two miners were sluicing the surface on the west side of the gully. The water was conducted through a water-race 3 miles in length; from a creek at the foot of the granite range.

"Payable gold has been got in most of the gullies around Mount Elvan. Three leads have been worked at the Upper Cape.

"The Canton Lead is situated on the western side of Gorge Creek. It runs in a direction W. 35° S. from a small gully called Little Bargoo Gully. The gold got in this gully was of the same character as that in the lead. At the mouth of this gully the same hypersthene-rock dyke crops out that is met with on Daunton's Hill. Payable gold was taken from surface workings at the head of the lead. The breadth of the lead near its head is about 30 feet, and its depth about 15 feet. The country on both sides of it is schist. Further down, where it junctions with a branch lead from Surface Hill, it is 100 feet in breadth.

"The drift consists of flat pebbles of schist, and rounded pebbles and boulders of granite. It has a horizontal stratification. The wash at the bottom consists of much coarser pebbles. The gold was chiefly wire-shaped.

"It has been worked entirely by Chinamen; they were sluicing it away in a face of about 25 feet in depth at the time I was there. The branch lead, heading from Surface Hill on the eastern side of Gorge Creek, was being sluiced by Daunton and party in Daunton's Gully. It is only in rainy seasons such as that of last year that water can be procured for sluicing purposes.

"The Pot-hole Lead is situated a little over a mile below the Upper Cape, on the south side of the river. In the river at the mouth of the lead there is an intrusive felspar porphyry of a reddish chocolate colour, which, in thin sections under the microscope, shows an undistinguishable groundmass having a flowing structure, full of ferrite and magnetite, and containing porphyritic crystals of oligoclase felspar. This rock extends for over half-a-mile down the river.

"Close to the river the drift is only 12 feet in thickness. The wash contains large boulders of granite, some of them over 2 feet in diameter. Pebbles of red oxide of iron occur in the drift, and are looked upon as a good indication of the presence of gold. Two hundred yards south of the river the average depth of the shafts is 30 feet. A few pebbles of olivine basalt occur here, and also small pieces of rounded olivine, called 'green painters' by the miners, which are said to be a certain indication of gold in the wash. The presence of the basalt points to the fact that the drift must be of a great age, as no basalt occurs in the district now, with the exception of the dyke before mentioned, and that on Mount Black, about 6 miles up the river from here. The basalt pebbles are probably the detritus of the basaltic outflow of which the small patch on Mount Black is now the only remnant. The other materials of the drift are similar to those in the Canton Lead.

"The Bluff Lead was being worked by Chinamen about a quarter of a mile north of the above. It is of the same character as the drift deposits."

In 1867 the Warden estimated the population of the Cape at 900 Europeans and 100 Chinese, but gave no estimate of the gold produced. Before the Department of Mines began (in 1877) to publish Annual Reports, the population and production had greatly declined. In 1878 the population was estimated at 50 Europeans and 45 Chinese, and the production of gold at 3,000 oz.; in 1879 the estimated yield was



2,400 oz.; in 1880,\* reef gold 442 oz., alluvial 615 oz.; in 1881,\* estimated total 3,000 oz.; in 1882,\* estimated total 3,000 oz.; in 1883,\* reef gold 200 oz., alluvial 1,000 oz.; in 1884,\* estimated total 1,914 oz.; in 1885,\* estimated total 1,000 oz.; in 1886,\* estimated total 500 oz.; in 1887,\* reef gold 987 oz., alluvial 124 oz.; in 1888,\* estimated total 328 oz.; in 1889,\* reef gold 643 oz., alluvial 1,058 oz.; and in 1890,† estimated total 2,020 oz.

The Charters Towers Field stands first among Australian gold-producing areas. It will be seen that the above returns from the Cape are so small as scarcely to affect the totals credited to Charters Towers.

The richest part of the goldfield lies on the western edge of a large area of granitic rock. The granite varies from a type in which orthoclase felspar, mica, and quartz are the essential minerals, and hornblende an occasional or accidental mineral, to a type in which, in addition to the constant orthoclase and quartz, hornblende is the essential and mica the occasional mineral. Reference may be made to Mr. A. W. Clarke's Micro-Petrographical Notes. (*See post.*)

West of the granite several reefs are worked in less highly metamorphosed rocks, but not only are these reefs less rich in gold, but the gold is also more alloyed with silver. These rocks consist of quartzites, greywackes (of mixed quartz, felspar, and hornblende granules, with some mica), shales, and slates. The slates and shales are highly impregnated with iron peroxide. The stratified rocks strike as a rule N.W. and S.E., and dip at over 45° to N.E. and S.W. They afford no direct evidence of their age, but are covered unconformably by the Middle Devonian Limestone of Burdekin Downs.

The reefs in the central portion of the field have no uniform trend, but they have invariably an underlie to the north side of their outcrop, and generally at a comparatively low angle.

Down to the water-level the gold was "free" in a gangue of granitic débris and quartz, mixed with "brownstone" or decomposed pyrites. Below that level the gold occurs in quartz associated with a "mundic" composed of pyrites, galena, and zinc-blende, which has not proved hard to treat.

The greatest depth at which gold has yet been worked is 1,500 feet (vertical). This is in the Mills United Mine.

About sixteen miles south of Charters Towers gold occurs in thready hematite veins, which reticulate through a volcanic "Neck," named Mount Leyshon. This neck has been pierced partly through greywackes and slates, and partly through a porphyry. The porphyry is composed of straw-coloured silicated felspar, with crystals of orthoclase felspar and quartz, the latter occurring, however, most frequently in rounded blebs. It sends out veins through the greywackes and slates, and also through the granite which occurs to the north. The Neck is the once deep-seated pipe or core of a volcano, filled up with the fragmental material which supplied the ashly outbursts. This material varies considerably in texture, some portions being merely aggregations of fine felspathic dust, while others are agglomerates of coarse angular débris of broken porphyry, cemented together by a sparse matrix of dust felted with iron oxide. Broken crystals and rounded blebs of quartz are scattered throughout the matrix; in fact, the material is exactly such as could be manufactured from the waste of the porphyry. Crystals of felspar in some cases appear to have been developed in the ash, so that but for the granular and elastic appearance of the matrix, the resemblance to the adjacent porphyry rocks would be complete. The rock has for some time paid for passing through the stamps as a whole, picking the auriferous veins being an impossibility. Now and then larger masses of auriferous stone are met with. In the

\* Rands, *loc. cit.*, p. 18.

† Warden's Report for 1890.

lower levels auriferous iron and copper pyrites begin to be met with, and it is possible that deposits concentrated in reefs will be discovered. The Neck is of considerable extent, covering nearly 200 acres, and is auriferous from its northern end to its south-western extremity (Wallaby Point). It is singular that in the adjacent twin neck, Mount Mawe, the existence of payable gold has not yet been proved.

The total yield of Charters Towers and the Cape up to 31st December, 1890, is estimated at 2,078,531 oz. How much of this came from the Cape it is now impossible to say. During late years the amount has been comparatively insignificant, but it is probable that for the six or seven years prior to the opening of Charters Towers (in 1872) it was of considerable importance.

AVERAGE YIELD PER TON OF STONE CRUSHED AT CHARTERS TOWERS.

		Oz.	dwt.	gr.			Oz.	dwt.	gr.
1877	...	1	16	22	1884	...	2	0	10
1878	...	1	10	1	1885	...	1	18	9
1879	...	1	10	13	1886	...	1	17	4
1880	...	1	14	22	1887	...	1	16	6
1881	...	1	10	12	1888	...	1	8	18
1882	...	1	14	19	1889	...	1	10	9
1883	...	1	10	17	1890	...	1	5	13

YIELD OF CHARTERS TOWERS AND CAPE GOLD FIELDS.

Year.	Alluvial Gold.	REEF GOLD.		Total Gold.	Remarks.
		Tons of Quartz Crushed.	Oz. of Gold therefrom.		
To end of—	Oz.			Oz.	
1875	...	...	...	442,976 <sup>1</sup>	<sup>1</sup> Deduced from figures in Report of Department of Mines for 1872, p. 10.
1876	...	39,463	...	67,616	
1877	21,929 <sup>2</sup>	36,030	66,479	88,408	
1878	18,849 <sup>2</sup>	35,510	53,340	72,189	
1879	17,461 <sup>2</sup>	41,584	63,568 <sup>2</sup>	81,029	<sup>2</sup> "Tailings and alluvial."
1880	16,704 <sup>2</sup>	39,285	68,594 <sup>2</sup>	85,298	
1881	... <sup>4</sup>	45,378	82,324 <sup>5</sup>	82,324	<sup>3</sup> Does not include gold from pyrites.
1882	100 <sup>6</sup>	45,662	79,495 <sup>7</sup>	79,595	
1883	1,000 <sup>6</sup>	44,602	68,559	69,559	<sup>4</sup> Not estimated.
1884	3,099 <sup>8</sup>	52,568	106,236	109,335	
1885	1,000 <sup>8</sup>	70,164	134,650	135,650	<sup>5</sup> Includes gold from pyrites.
1886	... <sup>4</sup>	77,665	144,379	144,379	
1887	317 <sup>6</sup>	85,292	151,060	151,377	<sup>6</sup> Alluvial only.
1888	... <sup>4</sup>	81,698	117,432	137,522	
1889	1,900 <sup>6</sup>	108,828	165,352	167,252	<sup>7</sup> Includes gold from tailings.
1890	8,786 <sup>7</sup>	121,406	155,236	164,022	<sup>8</sup> "Tailings, alluvial, &c."
		Total ...	...	2,078,531	<sup>9</sup> "Tailings, &c."

GILBERT AND WOOLGAR GOLD FIELDS.

These fields, although coterminous with the Etheridge, differ from it essentially in their geological characteristics. The divide between Caledonia Creek (one of the heads of the Delaney River, a tributary of the Etheridge) and the Robertson River (a tributary of the Gilbert) is dotted over with little fragmentary tablelands of Desert Sandstone. The latter formation, as mapped by the late Mr. Richard Daintree, occupies considerable areas in the Newcastle and Gregory Ranges, and between Agate Creek and the Percy River. The conglomerate beds of the formation are rich in agates, topazes, garnets, and other precious stones, including, it is said, rubies, sapphires, and diamonds.\* Another belt of the Desert Sandstone makes its appearance at the heads of the Woolgar,

where it is capped by basaltic rocks, probably of Tertiary age. Beneath the Desert Sandstone lie the metamorphic auriferous rocks of the Gilbert and Etheridge Gold Fields.

According to a geological map of the Gilbert, published by Daintree in 1869, the country near the junction of the Robertson with the Gilbert is composed of "slates, shales, &c.," of Lower Silurian age, skirting west-north-west. Regarding the age of the rocks in question, I am not aware that there is any direct evidence beyond their general lithological resemblance to Victorian Lower Silurian rocks. The upper waters of the Robertson and heads of the Gilbert are mapped as "metamorphic-mica schists" striking west-south-west. These and the "slates, shales, &c.," are penetrated by numerous dykes of "elvanite, diorite, hornblende rocks, &c.," and it is noted that "where these elvanites penetrate slates, payable gold is usually obtained."

The geological characteristics of the Woolgar Gold Field are similar to those of the Gilbert.

The output of the Gilbert is impossible to estimate, as the returns have been hopelessly mixed up with those of the Etheridge. In 1877 the Warden reported that in the years 1869-1872 the field "gave employment to a large number of European and Chinese miners, but from a variety of reasons it has been entirely abandoned for upwards of three years, but it is again showing signs of renewed activity."

In 1878 there was a considerable accession to the population engaged in alluvial working, and preparations were being made to re-open abandoned reefs. In 1879 the earnings of 500 Chinese were estimated at a minimum of 7,000 oz. of gold. In the same year the Gilberton Gold-mining Company crushed 420 tons of stone for a yield of 142 oz. 15 dwt. In 1880 the alluvial diggings were estimated to have yielded 6,260 oz. In the Warden's reports after 1880 no separate estimate is made. In 1885 the Warden reported that the Mount Hogan and Twenty-mile Reefs had crushed during the year 162 tons for 365 oz. of gold.

In 1887, 450 tons of stone were crushed at Mount Hogan, for a yield of 1,030 oz. of gold, and the population of Gilberton had dwindled to two Europeans. In 1888 the Mount Hogan machine crushed 1,112 tons for 1,958 oz. For 1889 I am unable to give the yield of Mount Hogan, but the Gilberton machine is reported by the Warden to have crushed 207 tons, the crushing giving over 1½ oz. to the ton. In 1890, a 10-head battery was fully employed at Mount Hogan during the whole of the year, and 1,159 oz. 19 dwt. 3 gr. of gold were sold to the Charters Towers banks. At Gilberton little crushing had been done during the year, but the Charters Towers Warden reports 108 oz. 19 dwt. 18 gr. of Gilberton gold purchased by the banks.

In the case of the Woolgar, the returns up to 1882 are to some extent mixed up with those of the Etheridge, but, so far as they can be separated, the following are taken from the Warden's books:—

YIELD OF WOOLGAR GOLD FIELD.

Year.	Tons of Stone Crushed.	Yield of Gold.	Alluvial Gold.	Total Gold.
		Oz.	Oz.	Oz.
1880 ... ..	...	...	2,500	2,500
1881 ... ..	...	...	500	500
1882* ... ..	...	...	...	...
1883 ... ..	1,200	2,400	200	2,600
1884 ... ..	1,734	1,976	350	2,326
1885 ... ..	5,006	3,940	...	3,940
1886 ... ..	2,819	2,079	350	2,429
1887 ... ..	694	709	...	709
	11,453	11,104	3,900	15,004

\* Returns included in those of the Etheridge.

In 1888 the Warden reported the field briefly as "dormant," in which condition it may be said to remain, although the Charters Towers Warden mentions 461 oz. of Woolgar gold purchased by the banks in 1890.

"Galena carrying silver is found in abundance on the [Gilbert] field. Near Gilberton three parties of men are opening galena lodes, from which some good assays of silver have been obtained. At the Percy River rich bismuth ore is found in gullies formerly worked for alluvial gold. Three men worked this ground for some time, and stacked a large quantity of washdirt containing ore. They also discovered a reef carrying the ore in small quantities. The absence of a market for the ore in the colonies, and the uncertainty as to the price obtainable in England, have had the effect of discouraging the miners, and work has now been discontinued."\* The ore referred to is the carbonate of bismuth, and what samples I have seen of it are almost chemically pure. "The principal lodes are found towards Gilberton, viz.—Galena, large, carrying a good percentage of gold and silver, and pure galena; bismuth, and bismuth and copper; copper; silver, with lead and sulphur; silver; silver and antimony; and so on. They are of various colours, and some of the lodes are of great width, and traced for miles along the surface of the ground. Tin is also met with, tin and copper having been worked on the east of the Einasleigh River."† "Silver in galena lodes, with a percentage of gold and indications of copper, exists on the Woolgar."‡

#### COEN GOLD FIELD.

As an alluvial field, the Coen had a short existence (from February to July, 1876). The country-rock is granite, greywacke, mica-schist, and quartzite. The alluvial gold was poor in quality and insufficient in quantity. Several reefs occur in the neighbourhood of the diggings. One of these, the Llankelly, has been worked profitably for a few years back.

#### NORMANBY AND MARENGO GOLD FIELDS.

##### NORMANBY.

There are no less than three goldfields in the Colony known as Normanby. The one here referred to lies about forty miles south of Bowen, on the heads of the Dart and Grant, tributaries of the Broken River.

The goldfield occupies a portion of the Clarke Range. That range consists almost entirely of metamorphic rocks. That these have undergone metamorphism, followed by extensive denudation, prior to the date of the Lower Bowen River formation, is proved by the relations they bear to the Bowen River Coal Field. In some places shales, slates, quartzites, greywackes, lydian stone, and mica and hornblende schists are met with; and there is little doubt that the whole tableland was originally composed of stratified rocks. In the immediate neighbourhood of Normanby, however, the occurrence of stratified rocks is notably rare, and the country-rock mostly consists of a species of porphyry, composed of quartz, black mica (sparsely), and crystals of schorl. The whole rock is mixed up with minute crystals and streaks of pyrites, and streaks and veins of serpentine. Occasional sections show a passage from greywacke to the rock just described.

In 1872-3, the Hibernia, Grace Darling, Marquis, Welcome, Star of Hope, Albion, New Zealand, Venture, and other reefs were at work, and everything went well till the water level was reached, crushings of from 1 oz. to 2½ oz. being the usual return. At the water level, however, "mundic" took the place of the easily reduced "brownstone," and as at the time the treatment of complex auriferous ores was little understood, the claims one after another were abandoned, although the stone assayed

\* Warden's Report in Report of the Department of Mines for 1881.

† Mr. Warden Samwell's Report in Report of the Department of Mines for 1883.

‡ Mr. Warden Samwell's Report in Report of the Department of Mines for 1886.

sometimes as much as 8½ oz. to the ton. The field suffered for many years from an unjustly acquired bad reputation; had it been discovered fifteen years later it would probably have entered at once on a course of unchecked prosperity.

In 1888 several of the abandoned reefs again set to work, and the yield is set down as 205 oz. In 1889, 109 oz. are credited to the field. Both of these amounts probably represent alluvial gold, as crushing machinery had been erected but not started to work. In 1890, 759 tons of stone yielded 569 oz. of gold, 189 oz. of alluvial gold bringing the total to 758 oz. Recently some of the mines are reported to be on rich stone.

From 1877 to 1883 the Annual Reports of the Department of Mines give the following statistics of gold from "Normanby, Marengo, and Mount Wyatt." The greater part must have come from Normanby, and was probably chiefly alluvial gold:—

1877	...	...	...	...	...	...	...	...	Oz. 220
1878	...	...	...	...	...	...	...	...	635
1879	...	...	...	...	...	...	...	...	712
1880	...	...	...	...	...	...	...	...	406
1881	...	...	...	...	...	...	...	...	273
1882	...	...	...	...	...	...	...	...	308
1883	...	...	...	...	...	...	...	...	201
Total ... ..									2,755

#### MARENGO.

This small field lies about twenty-three miles south-west of Bowen, on a low tableland dividing the head waters of the Bogie from the parallel valley of the Don. The lithological description of this limited area may be applied to the whole of the range between the Burdekin and the coast—essentially a white granite, in which the mica is sometimes supplemented and occasionally replaced by hornblende, frequent bosses of intrusive pale pinkish felspar-porphry (the felspar highly acidic), and occasional small areas of gneiss and mica-schist and of little metamorphosed, or at least still recognisable, shales and greywackes. The description of the field ought properly to have been placed in the preceding Chapter, but is more conveniently included here, on account of its geographical connection with the Normanby Field.

About a dozen reefs were worked for a short time from 1871, but proved too poor for profitable working at the time, the crushings varying from 3 dwt. to a little over 1 oz. per ton. The caps of the reefs showed a good deal of carbonate of copper, and the gold was soon found to be mixed with copper and iron pyrites. With economical working, Marengo and numerous other fields similarly situated will some day pay to work. One or two of the reefs are good enough to pay now, but could not bear by themselves the whole of the expenses necessary to put the field in going order. A goldfield in its infancy offers an exception to the usual laws of trade. The mines must bear in common the expenses of the machinery, &c., without which they are themselves worthless. Instead, therefore, of there being a struggle for existence, each individual miner is directly interested in his neighbour's prosperity.

#### PEAK DOWNS GOLD FIELD.

The reefs in this goldfield occur in an area of crumpled and fissured metamorphic schists, slates, &c., near the township of Clermont. Daintree, in his "Geology of Queensland"\* refers these rocks to the "Lower Silurian Series, or even to the still older metamorphic system of Victoria," but the only direct evidence of their age is that a bed of limestone, apparently of Devonian age (Burdekin Beds), appears to lie unconformably on them. "The principal reefing country lies to the south of Clermont,

\* Quart. Journ. Geol. Soc., vol. xxviii., p. 301.

and extends from 2 to 3 miles west of Copperfield to Macdonald's Flat, a distance of about 7 miles. The reefs have a general east-and-west trend. In none of them can the work be said to have gone beyond the prospecting stage. I must point out that the depth to which these reefs have been tried exceeds in no case 150 feet or 160 feet, and only in a few cases has this depth been reached. The returns of the crushings, too, that have been kept do not give a fair account of their average yield of gold, for the returns of the earlier and best crushings have been lost. I certainly am of opinion that some of them will be found payable at deeper levels." (*Rands*.)

"Most, or I might say practically all, of the gold sent away from this field has been the yield of alluvial workings. Ever since the year 1862, when the first rush took place, thousands of ounces of alluvial gold have yearly been obtained. The returns of the gold sent away in earlier years have not been preserved. The yield, however, was much larger than of late years. This falling-off has been caused, to a great extent, by the dearth of water." (*Rands*.)

In addition to diggings in the recent alluvia of the gullies on both sides of the Drummond Range, gold has been obtained in large quantities from drifts covered by a flow of basalt. The Victoria Lead has been, perhaps, the richest deposit of gold in the district. At the summit of the hill, where the workings on it started, the washdirt was only 15 or 20 feet deep. About three-quarters of a mile to the north, where it ran under the basalt, it was 100 feet deep. Its average width is from 20 to 30 feet. A 30-oz. nugget was obtained from near the head of the lead. The washdirt is said to have averaged  $1\frac{1}{2}$  oz. to the load all the way through, and 24 loads in one part went 8 oz. per load. Daintree, in his "Geology of Queensland," says, with reference to the volcanic outbursts: "The more northern volcanic areas, those shown on the map north of lat.  $21^{\circ}$ , are probably contemporaneous with the upper volcanic series of the Victorian Geologist, and are probably of Pliocene-Tertiary age. The southern areas, viz., Peak and Darling Downs, &c., are older, agreeing with the Lower Volcanic of Victoria, which have been ejected through fissures, and have in no case a very extensive flow beyond the line of fracture through which they have issued. These may be referred to the Miocene epoch."

A still older, and in some respects a very remarkable, auriferous drift occurs in the Cement Hill, at Hurley's, and at the Four-mile. Cement Hill is described as consisting of "Firstly, from 15 to 30 feet of a conglomerate composed of boulders and pebbles of schist and small quartz pebbles, the whole cemented together by a clayey cement formed by the disintegration of the schist itself. This conglomerate is soft, but very tough to work in. The bottom 4 or 5 feet forms the washdirt in which the gold is found. Secondly, underlying the conglomerate is a fine-grained silt or shale from 1 to 4 feet in thickness, termed by the miners 'dig,' which is cut away to facilitate the bringing down of the wash above. Lastly, another drift of smaller pebbles and not auriferous. This rests on the auriferous schists of the district. The 'dig' contains *Glossopteris*, the characteristic plant of the Bowen River and Newcastle (N.S.W.) Beds, and therefore the deposit appears to belong to Carbonifero-Permian Series. The auriferous portion of the upper conglomerate or drift is said to contain, as an average, about 5 or 6 dwt. of gold per ton."\*

The above conclusion was quite warrantable while the presence of *Glossopteris* was understood to be an infallible test of the Palæozoic age of the strata in which it occurred. Such reasoning, however, has now entirely lost its force since Mr. Rands' discovery of *Glossopteris* in the Desert Sandstone.†

\* W. H. Rands' Report on the Geology and Mineral Deposits of the Country in the Vicinity of Clermont. Brisbane: by Authority: 1886.

† See remarks under "The Organic Remains of the Desert Sandstone."

The returns from the Peak Downs Gold Field are very imperfect. For the first fifteen years of the history of the field I can only find one record by the Warden (of 4,900 oz., escorted in 1867). It cannot possibly be over the mark to fill up the blanks in the record as I have done by taking 4,000 oz. as the average annual yield from 1862 to 1866 inclusive, and 3,000 oz. annually from 1868 to 1876 inclusive. The recorded returns, with these additions, give a total yield of 110,853 oz. of gold. Gold to the amount of 6,294 oz. is returned as the yield of 12,461 tons of quartz crushed, but it must be remembered that Mr. Rands points out that the records of the earlier and richer crushings have been lost.

YIELD OF PEAK DOWNS GOLD FIELD.

Year.	REEF GOLD.		Alluvial Gold.	Total Gold.	Remarks.
	Stone Crushed.	Gold therefrom.			
	Tons.	Oz.	Oz.	Oz.	
1862-1866	...	...	...	20,000 <sup>1</sup>	<sup>1</sup> Estimated.
1867	...	...	...	4,900 <sup>2</sup>	<sup>2</sup> Escorted.
1868-1876	...	...	...	27,000 <sup>1</sup>	
1877	...	...	...	3,000	
1878	2,673 <sup>3</sup>	1,670	2,330 <sup>?</sup>	4,000	<sup>3</sup> From Macdonald's Flat reefs alone.
1879	963	528	5,480 <sup>?</sup>	6,000	
1880	2,293	1,089	6,311 <sup>?</sup>	7,400	
1881	2,545	758	6,718	7,476	
1882	1,211	842	5,158	6,000	
1883	484	243	2,757	3,000	
1884	652	275	2,993	3,268	
1885	213	119	3,545	3,664	
1886	746	253	4,104	4,357	
1887	486	310	4,108	4,418	
1888	124	68	2,277	2,345	
1889	71	139	1,947	2,086	
1890	...	...	1,939	1,939	
		Total ...	...	110,853	

## PEAK DOWNS COPPER FIELD.

"This lode was discovered in 1862. It can be traced for over 1½ miles, running in an east-and-west direction. It has an underlie varying from 40° to 70° to the south. The country consists of foliated and contorted micaceous and hornblendic schists, dipping south-east. The outcrop is a gossan, consisting chiefly of red and brown hematite, with a little oxide of manganese, and carbonates of copper. The ores were oxides and carbonates of copper to a depth of about 75 feet vertical from the surface, a mixture of oxidised ores and sulphurets to a depth of 120 feet, and below that depth they were ordinary sulphurets of copper.

"The gossan at the surface was auriferous; assays of it give from 4 dwt. to 1 oz. 16 dwt. of gold per ton, and also up to as high as 5 oz. of silver per ton.

"The deepest workings were 66 fathoms. Most of the lode was taken out to a depth of 40 fathoms for a distance of half-a-mile. From 1862 to 1878, when the original company was wound up, about 100,000 tons of ore, averaging 17 per cent. of copper, were smelted at the company's own works. That would give 17,000 tons of copper, the value of which was over £1,250,000. Copper lodes, known as the 'Western Peak Downs Copper Lodes,' exist about 7 miles west of Copperfield. Rich sulphurets of copper were obtained from these." (Rands' "Geology, &c., of Clermont.")

J.

## CHAPTER IV.

### MIDDLE DEVONIAN (BURDEKIN FORMATION).

#### ARGENTINE SILVER FIELD.

Rocks of Devonian age occur in at least five localities in Queensland—viz., the Burdekin Valley, including the Broken and Fanning Rivers, the mountains north of the Reid River crossed by the Northern Railway, Clermont Central Railway, and Hunter and Marble Islands in the Northumberland Group.

It is possible and even probable that considerable areas coloured as schists, slates, &c., of undetermined age may yet be recognised as belonging to the Devonian, but for the present the localities above named are the only ones in which the presence of Devonian rocks has been determined upon sufficient evidence. The Rev. W. B. Clarke attributed a Silurian age to the slates, quartzites, &c., which cross the border of New South Wales into Queensland at the heads of the Severn River.

Aplin, in his "Report on the Upper Condamine,"\* speaks of the Silurian rocks extending connectedly along the southern border, but remarks on the fossils that "in general aspect they resemble the fossils of the diorite slates at Gympie" (page 5). He mentions only *Productus* and *Spirifer*, as occurring at Elbow Creek, Lucky Valley, together with crinoids and corals. To his statement regarding the resemblance of the fossils to those of Gympie, I attach greater weight than to his determination of two genera of Brachiopods which range up to a much later date than Silurian. Daintree (1872) appears to have regarded the greater part of the stratified rocks occurring in the eastern ranges of the Colony, with the exception of the Coal Measures, as Devonian†; and Mr. R. Etheridge, F.R.S., in his Appendix to Daintree's Paper, massed the fossils from the Gympie Beds with those from the Burdekin Beds as Devonian‡—a classification which later collections have shown to be untenable.

Gregory, in his "Geological Map of Moreton and Darling Downs (1879)," coloured the altered slates and sandstones extending from near the border northward to near Brisbane, and again from Brisbane to the heads of the Caboolture, as Devonian, and in his Report on the Geological Features of the South-eastern Districts of the Colony § describes them as such, and refers to the Gympie Beds as of the same age.

In my Geological Map, prepared for the Colonial and Indian Exhibition of 1886, I coloured the strata in the neighbourhood of Gympie as Lower Carboniferous, but had not yet seen any reason for disagreeing with Daintree's conclusions as to the Devonian age of the remainder of the altered stratified rocks which extend, with some interruptions, from Keppel Bay to the southern border. In my "Handbook of Queensland Geology" (Brisbane, 1886), I said (p. 23):—"It is with considerable hesitation that I class, in the meantime, the greater part of the Palæozoic rocks south of Marlborough as belonging to the Burdekin Beds. It is quite likely that among the highly inclined and much distributed rocks of this region strata will yet be found separable, on account of their fossil contents and their stratigraphical relations, from the rest, and of different ages. But fossiliferous limestones, apparently identical with the Burdekin

\* Brisbane: by Authority: 1869.

† Quart. Journ. Geol. Soc., vol. xxviii., p. 288.

‡ Loc. cit., p. 325.

§ Brisbane: by Authority: 1879, p. 7.



Beds, are so common in the whole region, that the attempt to separate them from the other strata, which, after all, present only the negative evidence of the absence of fossils, has proved hitherto a task beyond our powers. Attempts have been made in limited areas; but I do not think that sufficient evidence has as yet been accumulated to warrant the conclusions which have been drawn." In another place (p. 37) I added:—"Some slates containing *Fenestella*, &c., from the Training Wall Quarries, Rockhampton, forwarded by Mr. James Smith, so much resemble some of the Gympie Beds that, in the meantime, I map a small area as of the same age." Since then, however, Mr. Smith (now deceased) has brought to light a considerable collection of fossils from localities extending over the greater part of the Port Curtis District, as well as from Kooingal, sufficient to prove the identity of the strata over this wide tract with those of Gympie. Mr. Rands' collections from Raglan, Langmorn, Calliope, the Boyne, Cania, and Yarrol point to the same conclusion as regards these localities. The whole of the district, therefore, from Lat. 22° to Lat. 26°, with the exception of some limited areas of newer formations, has been removed from the Devonian and classed with the Gympie Beds.

At Burdekin Downs, and for six miles up the Burdekin River, the outcrop of a great mass of limestone is seen at intervals. The area occupied by its outcrop is marked by a greener vegetation than that which covers the surrounding country. The limestone must have formed a coral reef of great thickness. On its weathered surfaces the corals stand out in admirable relief, like triumphs of the sculptor's art. When the corals are examined under the microscope their cells are seen to be filled with calc-spar.

At the mouth of a little creek falling into the Burdekin between Arthur's Creek and Burdekin Downs Station, the limestone dips at about 10° to the north-west and rests directly on the granite. Its outcrop occupies half-a-mile, and its thickness should therefore be about 450 feet. It is succeeded by a bed of fine-grained, white, hardened sandstone or quartzite.

Arthur's Creek is understood in the district to be the same as "Terrible Creek, near Messrs. Cunningham's Cattle Station, Burdekin River," described by the late Mr. R. Daintree.\*

The limestone is probably the same as that referred to by Leichhardt in his "Journal of an Overland Expedition from Moreton Bay to Port Essington during the years 1844-5" (p. 241), in the following terms:—

"The opposite bank exhibited a very perfect and instructive geological section of variously bent and lifted strata of limestone, which were afterwards found to contain innumerable fossils, particularly corals, and a few bivalve shells." To one coral in Dr. Leichhardt's Collection, the late Rev. W. B. Clarke gave the name of *Cyathophyllum Leichhardti*.

On the Fanning River, north of the Fanning Station, a bed of limestone is seen composed to a large extent of the remains of Corals, with a few Brachiopods and at least one Cephalopod. In the above locality the limestone dips south-south-east at 20°. Beneath the limestone beds are some beds of granitic sandstone with calcareous concretions, the sandstone containing numerous impressions of Gasteropods, but the matrix is too friable for removal. North of the station paddock the base of the limestone is seen very near a mass of granite, on which probably the beds beneath the limestone rest.

East of the Fanning River the outcrop of the limestone forms a semicircular band of low scrubby hills (on which the Bottle-tree appears to have a favourite habitat), and returns to the river at the Old Station, five miles below the present station.

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\* Quart. Journ. Geol. Soc., vol. xxviii., p. 290.

Here the dip is to the west at  $25^\circ$ , and as the outcrop occupies a belt of four miles in breadth, the total thickness of the limestone beds must be nearly 7,000 feet. From the limestone near the Old Station I obtained, besides Corals, a few specimens of Brachiopoda. A calcareous shale immediately above the limestone yielded, in addition to corals and mollusca, the only plant—*Dicranophyllum australicum*, Dawson—yet found in the Devonian rocks of Queensland.

The ring of limestone underlies a basin of stratified deposits, consisting for the most part of grey, brown, and greenish flaggy sandstones, and greenish and chocolate-coloured shales. A few of the sandstone beds are white, and would be well suited for building purposes. From one of these white beds I obtained the specimen of *Dicranophyllum australicum* which was described by Sir J. William Dawson.

In the limestone of the scrubby hills above referred to are several large caverns, beautifully festooned with stalactites and stalagmites.

The Broken River falls into the Clarke River, one of the most important tributaries of the Burdekin, in Lat.  $19^\circ 30'$  S. and Long.  $145^\circ$  E. Mr. Daintree, in his Paper on the "Geology of Queensland,"\* wrote:—"On the track from the Broken River to the Gilbert Diggings, Devonian rocks, several thousand feet thick, may be observed, as they are continuous in dip, without being repeated, for at least five miles across the strike, with an average inclination of  $60^\circ$  . . . . On the Broken River and its tributaries a breadth of thirty miles, with a length of sixty miles, is occupied by a persistent outcrop of Devonian strata. . . . There the entire Devonian system, as developed in Queensland, could be easily and satisfactorily mapped. The branches of this river cut right across the strike, and the bare edges of the rocks are often exposed over the intervening ridges from creek to creek. Well-marked beds of interstratified conglomerates seem to retain their character over large areas, and the loose pebbles from these can be followed readily over the ridges, whilst the rock from which these pebbles are derived crops out in the gullies and ravines."

I had an opportunity of visiting this interesting locality in October, 1886, and traversed the river for about ten miles above the crossing of the road from Pentland to Gilberton. The strata strike north-east and south-west, and dip on the whole at high angles to the north-west. In the first mile above the crossing there is, however, first a synclinal trough and then an anticlinal arch, so that the outcrops of some of the strata are seen three times. Allowing for this repetition, the following section (in descending order) can be made out:—

	Feet.
1. (Ten miles up the river.) Hard grey or white and yellowish sandstone, sometimes weathering spheroidally, alternating with soft, thin, grey shales . . . . .	5,280
2. Soft, thin, grey shales (vertical: strike N. $35^\circ$ E.) . . . . .	1,000
3. Soft, grey, sandy shales or argillaceous sandstones, sometimes calcareous, and containing Corals, Crinoids, and Brachiopods (nearly vertical: strike N.E. and S.W., marked cleavage-planes, dipping to N. at $15^\circ$ to $25^\circ$ ) . . . . .	1,000
No section—room for . . . . .	300
4. Limestone (strike N.N.E. to S.S.W.—traced for two miles) . . . . .	300
5. Shales . . . . .	500
6. Fine conglomerates . . . . .	200
7. Limestone . . . . .	50
Carried forward . . . . .	8,630

\* Quart. Journ. Geol. Soc., vol. xxviii., pp. 290, 291.

	Feet.
Brought forward ... ..	8,630
8. Coarse conglomerate (pebbles up to one foot in diameter): pebbles of granite, porphyry, diorite, quartz, quartzite, hardened sandstone, and lydian stone (vertical: strike N.N.E. to S.S.W.) ...	2,640
9. Limestone, full of Crinoids and Corals, alternating with fine-grained, greenish-grey sandstones, and shales, seen at intervals ...	1,320
10. Shales, sometimes calcareous ... ..	100
11. Limestone, in parts an agglomerate of coral boulders, with partings of grey shale ... ..	500
12. Shales, with thin beds of limestone at intervals ... ..	1,320
13. Limestone ... ..	300
14. Shales ... ..	20
15. Fine-grained, dark-blue, calcareous sandstone, in thin beds ...	30
16. Shales, seen at intervals ... ..	100
17. Limestone, in thin beds, full of Corals ( <i>Favosites</i> , <i>Heliolites</i> , &c.) and Crinoids (strike N.N.E., dip N.N.W. at 75°) ... ..	12
18. Dark grey-green, crumbling slates or shales, seen at intervals ...	600
19. White grit ... ..	20
20. Limestone (coralline) ... ..	600
No section—room for ... ..	500
21. Limestone (coralline) ... ..	300
22. Fine quartz-conglomerate or pebbly grit ... ..	30
23. Conglomerate, pebbles chiefly of sandstone up to six inches in diameter, reddish matrix (strike N. 30° E., dip W. 30 N. at 70°) ... ..	50
24. Slate, seen at intervals ... ..	100
25. Quartz-conglomerate; the upper part has pebbles of hardened, fine-grained, grey and greenish sandstone as well as quartz, with partings of grit and shale (strike N.N.E., dip N.N.W. at 70°) ...	400
26. Slates and greenish-grey flags, seen at intervals (strike N.N.E., dip N.N.W. at 75°) ... ..	1,320
27. Thick-bedded, hardened, grey and greenish siliceous grits, with shale partings (strike N.E., dip N.W. at 70°) ... ..	100
28. Thick-bedded, hardened grey and greenish siliceous grits (strike N. and S., vertical) ... ..	200
29. Green, decomposed, fine-grained, viriditic, metamorphic rock, passing into contorted green slate or schist (vertical: strike N.E. to S.W., dip N.W.) ... ..	2,640
30. Coarse altered grit containing crystals of felspar and hornblende ...	2,640
31. Hardened white sandstone, almost quartzite ... ..	100
32. Thick-bedded, hard, white siliceous sandstone (strike E.N.E., dip N.N.W. at 75°) ... ..	50
33. Conglomerate; pebbles, hard white siliceous sandstone and quartzite, a few slate, and a very few of quartz ... ..	30
No section—room for ... ..	50
34. Thick-bedded, hardened, white siliceous sandstone ... ..	150
No section—slates seen at intervals—room for ... ..	150
35. Blue slates and sandstones (dip N.N.W. at 60°), say ... ..	500
No section—room for ... ..	300
36. Fine-grained, blue, slaty sandstone ... ..	100
37. (At road crossing.) Blue slates (dip W. at 20°, cleavage N.E. and S.W.) ... ..	800
38. Coarse conglomerate ... ..	300
	<hr/>
	20,782

Away from the river the two beds of limestone, Nos. 20 and 21, are separated by a hollow (denoting the prevalence of soft rocks, probably shales), in which débris of shale or slate, and lumps of manganese oxide and hematite, can be seen in the soil. Both beds of limestone are covered on the top with bottle-trees. These beds cross the road about three miles north of the river, and contain numerous caves, in some of which gold has been obtained on washing the detritus on the floor.

As the whole of the strata comprised in the above section are evidently part of an unbroken series, and the limestone beds have, from their fossil contents, been identified with those of the Burdekin Beds, the whole thickness (20,782 feet) must be considered as belonging to the same division of the Devonian rocks. How much more would be added to this by following the Broken River down to its junction with the Clarke, I cannot say.

From the Broken River the Pentland and Gilberton road runs north-west to McKinlay's (twenty miles). Two miles beyond the "Limestone Wall" (bed No. 20 in the above section), the road crosses soft, white, yellow, greenish, and liver-coloured sandstones, with partings of grey and occasionally liver-coloured shales; then a six-foot bed of limestone-conglomerate, containing pebbles of limestone (chiefly), sandstone, and conglomerate, in a limestone matrix. The limestone pebbles are masses of coral. This singular conglomerate strikes north-north-east to south-south west, and is succeeded to the north-west by red shales. For the next mile the road crosses grey sandstones, to which several thin beds of limestone succeed. Thence to McKinlay's the road crosses gritty yellow sandstones.

About a mile north of Pandanus Creek (on which McKinlay's Station is situated) is a thick bed of limestone, said to be traversed by an antimony lode. From McKinlay's north-west for about eight miles (across the divide between the Burdekin and Einasleigh waters) the road crosses several beds of limestone alternating with brown and white sandstones and red shales. After seventeen miles more, in which no strata crop up on the road, basaltic rocks are met with, which continue for at least fifteen miles more to the Lynd Station, on Lee Creek, a tributary of the Einasleigh. It is probable that the basalt overlaps the stratified rocks just described.

The whole of the stratified rocks, which include several beds of limestone, met with along the road north-west of the Limestone Wall in all probability belong to the same series as the limestone in the wall itself. Some of the sandstones and liver-coloured and greenish shales remind one strongly of the shales above the Fanning Limestone.

In returning, in December, 1886, to Townsville from the Croydon Gold Field, *via* Georgetown, I took the direct road from the Lynd Station to Townsville, which crosses the Clarke River at the Telegraph Station near its mouth. Eight miles from the Lynd Station the basalt country comes to an end. In two miles more the divide, here almost imperceptible, between the Einasleigh and Burdekin waters is crossed. Granite is seen on the road for the next three miles. To the granite succeed twelve miles of mica-schist country, with numerous quartz reefs. After two miles of basalt the valley of Paddy's Gully is reached. The gully is in mica-schist, which extends along the road half-a-mile on either side of the gully. Then comes half-a-mile of stony basalt country; then two miles of mica-schist and two of basalt; thence to two miles short of Gray Creek (five miles) mica-schist is met with. I regard the mica-schists met with between this point and the divide as of an older date than the Broken River Limestone and associated strata.

At the point (two miles short of Gray Creek) where the mica-schist is seen for the last time, strata similar to those on the Pentland road, north-west of the Limestone Wall, are met with. The first eight miles are over red shales, partly jasperised. As far

as Doughboy Creek (sixteen miles) the road crosses highly inclined brown and yellow sandstones. Near Doughboy Creek these beds are overlaid unconformably by tablelands of Desert Sandstone, which extends south-westward nearly to the Broken River. For the next six miles, to Christmas Creek, the road traverses brown and yellow sandstones, grits, and conglomerates. Near Christmas Creek amygdaloidal porphyrite is seen on the road, but its relation to the sandstones, &c., could not be made out. Beyond this point the setting in of the wet season made further geological observations impossible, so that I am unable to say how far the Devonian rocks extend to the east of the Clarke River.

The strata seen on the Townsville road nearest the mica-schists, it must be remembered, are high up in the Devonian Series. They therefore, probably, do not in this locality overlie the mica-schists, but are most likely divided from the latter by a fault.

Referring again to the section seen on the Broken River, it will be observed that the thick limestone, No. 20, is the lowest bed in which I have actually observed the occurrence of fossils, although the time at my disposal was far too limited to admit of a careful search. For anything, therefore, that can be proved to the contrary, the underlying beds, which have a thickness of 10,000 feet, may pass downward into the Lower Devonian or even Silurian. But no such division can be made without *positive* evidence, and as the whole section of 20,782 feet forms an unbroken series it must for the present be regarded as Middle Devonian.

When the "Handbook of Queensland Geology" was published, I was under the impression that the strata above described as lying on the Fanning Limestone were the equivalent of the "Dotswood Beds" in the Keelbottom Valley, and that both were on a lower horizon than the "Star Beds." The "Star Beds" form the lowest member of the Permo-Carboniferous Series, and therefore are, probably, most nearly related homotaxially to the European Carboniferous.\* More recent observations have shown (1st) that the "Dotswood Beds" and the "Star Beds" are identical; and (2nd) that the strata lying above the Fanning Limestone are the equivalents of similar strata which overlie the Broken River (Middle Devonian) Limestone, and with which thin beds of limestone containing the same fossils as the Broken River Limestone itself are intercalated. The strata above both the Fanning and the Broken River Limestones are now regarded as belonging to the same formation as these limestones, and as there can be no passage from Middle Devonian into Carboniferous, the "Star Beds," with which the "Dotswood Beds" are now united, must be unconformably related to the former.

Part of this area is further described by Mr. Maitland in his Report on the Geology and Mineral Resources of the Upper Burdekin,† as follows:—

"The series of strata classed under this head [Burdekin Beds] occupy a very extensive tract of country.

"The basin is bounded on the west by a belt of schistose rocks of variable width, and on the north and west by the granitic rocks which make up the main coast range. Small patches of schistose rocks, however, are seen near the tin lodes at Kangaroo Hills, separating the Burdekin Beds from the granite, but of too small an area to be shown on the map.

"In their lithological characters they present a marked contrast to the rocks above and below them. The strata consist for the most part of dark-buff and reddish

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\* It is probable that the "Star Beds" are the equivalent of what in New South Wales are at present known as the "Lower Carboniferous," but which, it is anticipated, will in future be regarded as the nearest representative of the Carboniferous of Europe. These I have now termed Carboniferous in the New South Wales Classification. (See Mem. Geol. Survey, N. S. Wales, Pal. Series, No. 5, pt. 1, 1891, p. 3.—*R. E. junr.*)

† Brisbane: by Authority: 1891, p. 4.

coloured shales, sometimes jasperised, together with grits, greywackes, and quartzites generally inclined at high angles. The thickness of these beds, unless repeated by folding, must be very great.

"From their lithological characters it appears possible to divide them into two subdivisions, one consisting for the most part of reddish shales and ferruginous chocolate-coloured sandstones, and the lower of dark shales, grits, and greywackes. From the fact that these reddish beds were first seen near Wairuna Station, for convenience of description I have named them the Wairuna Beds.

"From the Four-mile Creek—a tributary of the Douglas—to Kangaroo Hills Station the gullies show buff-coloured vertical shales and greywackes, striking generally east and west.

"The eastern bank of the river at Kangaroo Hills Station is composed of buff shales and greywackes, which dip at an angle of  $80^{\circ}$  N.  $70^{\circ}$  W., and strike N.  $30^{\circ}$  E.

"Near the tin lodes, the 'Star Beds' are seen to rest upon a series of highly inclined hardened grits and shales. In close proximity to the granite beds hardened and metamorphosed are met with; to ascertain whether these are representatives of the Burdekin Beds more highly altered, or are of older date, would require much more detailed work than is possible in a flying reconnaissance.

"From Kangaroo Hills Station to the mouth of Camel Creek the country is occupied by vertical shales of a somewhat similar type to those above described. In Tomahawk Creek they strike W.  $20^{\circ}$  S. Between this point and the crossing of the Douglas the sedimentary strata are intersected by a tongue of granite.

"From the mouth of Camel Creek to a gully about 2 miles further down the river the country is made up of vertical contorted shales and greywackes; at the south end of the section their strike is north and south, at the mouth of Camel Creek it has veered round to west-north-west.

"A few low hills of flaggy grits, dipping at angles of from  $25^{\circ}$  to  $30^{\circ}$  to the northwards, are passed over in traversing the country from the mouth of Camel Creek to a point on the opposite side of the Burdekin to Greenvale Station.

"To the Valley of Lagoons Station comparatively few sections are to be seen, owing to extent of flat country covered with recent superficial deposits. At one place about 5 or 6 miles north of Greenvale Station, ridges showing vertical sandstones striking north-east and south-west occur. These bear a strong lithological resemblance to those last described. Similar beds underlie the flats for the next few miles, then their place is taken by reddish jasperised shales. The relation of these shales to the sandstones is not very clear, but I am inclined to regard them as being separated by a fault.

"Further northwards along the road the eye is attracted, even at a distance, by a conspicuous cliff about 100 feet in height. On nearing it the western face was found to be full of caverns of no great size, and the base was strewn with huge boulders of rock. The matrix of which this hill is composed is a quartz rock generally with a reddish tinge, though sometimes white. It appears to be bedded, the bedding planes being nearly vertical and striking north and south. Some of the weathered surfaces suggest a volcanic origin (ash?).

"Underlying the flats of the next mile or two are shales, &c., dipping at  $25^{\circ}$  to  $30^{\circ}$  to the north-east.

"The country to the east of the station at the Valley of Lagoons is occupied by fine-grained sandstones of a yellowish-brown or buff colour. In some places the sandstones are crowded with sun-cracks. They rest unconformably upon the schists, and dip to the south-east at angles varying from  $70^{\circ}$  to  $30^{\circ}$ . They do not form any important feature in the landscape.

"In the vicinity of Wairuna Station, vertical shales of a reddish-purple colour strike north and south, some of which look not unlike fine volcanic ashes. At one place west from the station some of the shales are found to be associated with thick beds of quartzite; these strike north-east and south-west. The Wairuna beds are seen cropping up at intervals along the track to Lake Lucy Station.

"The environs of Lake Lucy are made up of reddish clayey shales, identical with those above described, and having the same general trend—viz., north-east and south-west. Interstratified with these shales are bands of limonite intermingled with veinlets of quartz. These bands are not continuous for any distance. All of these examined were parallel with the bedding planes, and of very variable thickness. A few quartz reefs intersect these shales. Between Lake Lucy and Oak Hills, the Wairuna Beds occupy the country; they retain the same character and strike. Unless repeated by faulting and folding (which is not improbable) these Wairuna Beds must be of enormous thickness.

"Among the rocks above described there may be beds which future detailed mapping may prove to belong to other systems.

"At present, in the absence of palæontological or stratigraphical evidence, the whole beds are provisionally classed as belonging to one system."

The hill to the north of Torrent Creek, on the western side of the Reid Gap, is capped by a stratified deposit. The lowest strata are of limestone, of a total thickness of about 60 feet, divided by occasional thin layers of hardened sandstone. The deposit varies in quality from top to bottom, some strata being dark-blue limestone, and others white saccharine marble. Some of the blue beds are full of fossil corals. Above the limestone is a thickness of about 40 feet of hardened grey mudstones with calcareous bands. The strata on this hill-top dip N. 30° E. at about 25°.

The hill on the opposite or eastern side of the Gap is likewise composed of stratified deposits, as follow:—

	Feet.
1. Hardened white sandstone or quartzite partly conglomeratic ...	3
2. Sandstone (thickness uncertain) ...	...
3. Good blue limestone with corals, say ...	30
4. Hard mudstones and fine-grained hardened sandstones (almost quartzites), with limestone in bands along bedding planes ...	80
5. Good blue limestone (base contelead by talus) ...	...

The strata numbered 4 and 5 in the above section are the same as those already described as capping the hill on the opposite side of the valley. The limestone at the base of the section last given lies directly on granite.

On the hill-tops west of the railway at Double Barrel Creek, the following strata dip to the south-west, and rest unconformably on greywackes, &c., probably of the same age as the stratified rocks west of Charters Towers:—

	Feet.
Dark-blue limestone, full of corals; the lower part only divided by partings of quartzite, at least ...	200
Alternate quartzite, limestone, and marble bands, say ...	100
Blue greywacke ...	1½
Alternate quartzite and limestone bands ...	40
Dark-blue greywacke ...	5
Scrub, perhaps covering ...	20
Limestone with quartzite bands ...	40
Fine-grained dark-blue greywacke ...	4
Impure saccharine marble, with dark streaks ...	15
Dark-blue coralline limestone, about ...	60

In the neighbourhood of Clermont a bed of dark crystalline limestone crops out close to Douglas Creek, about three miles below its junction with Drummond Creek, and about four miles south-east of Copperfield. The limestone is full of corals, among which Mr. Rands recognised *Favosites*, *Chaetetes*, *Cyathophyllum*, a compound cyathophylloid resembling *Strombodes*, and *Stenopora* (?), together with a fragment of a Lamellibranch shell.\*

In Marble Island, in the Northumberland Group, a limestone is extensively quarried. In some cargoes of this limestone I have seen corals of the species which characterise the Burdekin Beds.

In 1887 I had an opportunity of visiting Hunter Island, which lies about half-a-mile west of Marble Island, in Lat.  $21^{\circ} 58'$  S. and Long.  $149^{\circ} 9'$  E. The island extends from north to south about a mile and a-quarter, and has an average breadth of less than a quarter of a mile. It is well grassed, but the timber is confined to a few trees on the beach, among which are some hoop pines. The southern portion of the island is joined to the northern by a narrow neck or isthmus, and is wholly composed of granite. In the bay, on the eastern side of the neck, and in the wide portion of the island to the north, a series of stratified rocks make their appearance. They have a north-and-south strike, and dip to the east at  $65^{\circ}$ , being, in all probability, divided by a fault from the granite on the south. The uppermost (easternmost) bed seen is a white marble at the north end and a blue limestone at the south. Below this, to the west, comes a considerable thickness of highly contorted shales or slates, with seams, nodules, and lenticular patches of coralline limestone. Next comes a thick bed of blue limestone, which graduates northward into pink marble. Sandstones and conglomerates underlie the bed last mentioned, and are best exposed in the bay on the east side of the isthmus. The last and lowest bed seen is at least 100 feet in thickness. On the east side of the isthmus it is an ordinary blue limestone. On the edge of the bay to the north, its upper part is white and its base a pink marble. Considerations of wind and tide made my visit to the island, in spite of the time consumed in reaching it, a very short one, and I had no time to search for fossils. There is no reason to doubt, however, that the limestone and other stratified rocks of Hunter Island are of the same age as the limestone of Marble Island. The northern end of Marble Island is composed of limestones, &c., and the southern end of granite, so that it is probable that here, as in Hunter Island, the stratified and plutonic rocks are divided by a fault.

It is noticeable that the northern portions of the outcrops of the three large beds of limestone in Hunter Island have become changed from the usual type of blue-grey limestone into marble. There is no visible cause for this development of "regional metamorphism," but it is likely to be due to deep-seated igneous rocks or hydrothermal action. As the limestones, &c., were laid down subsequent to the formation of the granite, and, where seen, at the southern part of the isthmus, in closest proximity to it, are quite unaltered, it is evident that the latter can have had nothing to do with it. The western half of the northern portion of the island is composed of granite like its southern extremity, and it is probable that the stratified rocks were deposited on the granite long subsequent to its consolidation. A mass of diallage-rock is seen on the western shore of the island, apparently intrusive through the granite.

The limestone, of which there is an unlimited quantity, would serve admirably for a building stone or for the manufacture of lime. Some argillaceous portions would make hydraulic lime. The marble is minutely crystalline and pure white, and quite fit for ornamental architecture or statuary. What I have above alluded to as "pink" marble is a very beautiful stone suffused with a faint blush-rose tint.

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\* Report on the Geology and Mineral Deposits of the Country in the Vicinity of Clermont. Brisbane: by Authority: 1886, p. 4.



In the following list of fossils from the Devonian rocks of Queensland, all are included which my Colleague has recognised or admitted. The species are distributed among the four localities from which collections have been made, but these localities are practically on the same horizon.

# SYSTEMATIC LIST OF MIDDLE DEVONIAN FOSSILS.

	Broken R.	Fanning.	Burdekin.	Reid.
Kingdom—PLANTÆ. Section—PHANEROGAMOUS PLANTS. Class—EXOGENÆ. ? Order—CONIFERÆ. Genus—DICRANOPHYLLUM, Grand'Eury. <i>Dicranophyllum australicum</i> , Dawson ... ..	...	x		
Kingdom—ANIMALIA. Sub-Kingdom—CœLENTERATA. Class—HYDROZOA. Order—HYDROCORALLINÆ. Family—STROMATOPORIDÆ. Genus—STROMATOPORA, Goldfuss. <i>Stromatopora, sp. ind.</i> , Pl. 1, figs. 3-5 ... ..	x	...	x	x
Class—ACTINOZOA. Order—ZOANTHARIA. Sub-Order—Z. SCLERODERMATA. Section—PERFORATA. Family—FAVOSITIDÆ. Genus—FAVOSITES, Lamarck. <i>Favorites gothlandica</i> (Foug.), Lamarck ... .. Genus—PACHYPORA, Lindström. <i>Pachypora meridionalis</i> , N. & E. fil. ... .. Genus—ALVEOLITES, Lamarck. <i>Alveolites alveolaris</i> , De Koninck, Pl. 2, figs. 1-3a ... .. " var. <i>queenslandensis</i> , Eth. fil. and Foord, Pl. 2, figs. 4-6 ... .. " <i>robustus</i> , Rominger, Pl. 1, figs. 13, 14 ... .. " <i>sp. ind.</i> , Pl. 1, figs. 15-17 ... .. Genus—AMPLEXOPORA, Ulrich. <i>Amplexopora (?) Koninckii</i> , Eth. fil. and Foord, Pl. 2, figs. 7-9a ... .. Genus—TRACHYPORA, Edw. and Haime. <i>Trachypora, sp. ind.</i> , N. and E. fil. ... .. Genus—STRIATOPORA, Hall. <i>Striatopora (?) uniseptata</i> , Eth. fil. ... .. Genus—ROMINGERIA, Nicholson. <i>Romingeria (?) Foordi</i> , Eth. fil. ... .. Genus—CENITES, Eichwald. <i>Cenites, sp.</i> ... ..	x	x	x	x
Family—PORITIDÆ. Genus—AREOPORA, N. and E. fil. <i>Araopora australis</i> , N. and E. fil., Pl. 3, figs. 6-9 ... ..	...	...	x	
Section—RUGOSA. Family—CYSTIPHYLLIDÆ. Genus—CYSTIPHYLLUM, Lonsdale. <i>Cystiphyllum americanum</i> , Edw. and Haime, var. <i>australe</i> , Eth. fil., Pl. 3, figs. 13, 14 ... .. Genus—CYATHOPHYLLUM, Goldf. <i>Cyathophyllum, sp. ind.</i> , Pl. 3, figs. 11, 12 ... ..	...	...	...	x

## SYSTEMATIC LIST OF MIDDLE DEVONIAN FOSSILS—continued.

	Broken E.	Fanning.	Burdekin.	Bald.
Family—ZAPHRENTIDÆ.				
Genus—AMPLEXUS, <i>J. Sowerby</i> .				
<i>Amplexus</i> , <i>sp. ind.</i> , Pl. 37, figs. 15, 16... ..	x			
Genus—CAMPOPHYLLUM, <i>Edw. and Haime</i> .				
<i>Campophyllum Gregorii</i> , <i>Eth. fil.</i> , Pl. 3, figs. 15-18 ... ..	...	...	...	x
Order—ALCYONARIA.				
Family—HELIOLITIDÆ.				
Genus—HELIOLITES, <i>Dana</i> .				
<i>Heliolites porosa</i> , <i>Goldf.</i> , Pl. 1, fig. 6 ... ..	x	x	x	
„ <i>Daintreei</i> , <i>Eth. fil. and Nich.</i> , Pl. 1, figs. 7, 8 ... ..	x			
„ <i>plasmoporoides</i> , <i>Eth. fil. and Nich.</i> , Pl. 1, figs. 9-11 ... ..	x			
„ <i>Nicholsoni</i> , <i>Eth. fil.</i> , Pl. 1, fig. 12 ... ..	x			
Family—AULOPORIDÆ.				
Genus—AULOPORA, <i>Goldf.</i>				
<i>Aulopora repens</i> , <i>Edw. and Haime</i> ... ..	...	...	x	
„ <i>sp. ind.</i> ... ..	...	...	...	x
Sub-Kingdom—ECHINODERMATA.				
Section—PELMATOZOA.				
Class—CRINOIDEA.				
Order—PALÆOCRINOIDEA.				
Crinoid stems ... ..	x			
Sub-Kingdom—MOLLUSCA.				
Class—BRACHIOPODA.				
Order—TRETENTERATA.				
Family—SPIRIFERIDÆ.				
Genus—SPIRIFERA, <i>J. Sowerby</i> .				
<i>Spirifera curvata</i> , <i>Schlotheim</i> , Pl. 37, figs. 3-5, 7 ... ..	...	x		
„ <i>enryglossa</i> , <i>Schnur</i> , Pl. 4, fig. 1 ... ..	...	x		
Family—ATREPIDÆ.				
Genus—ATRYPA, <i>Dalman</i> .				
<i>Atrypa reticularis</i> , <i>Linnæus</i> , Pl. 4, fig. 4 ... ..	...	x		
„ <i>desquamata</i> , <i>J. de C. Sowerby</i> , Pl. 4, figs. 2, 3; Pl. 37, fig. 8 ... ..	...	x		
Family—RHYNCHONELLIDÆ.				
Genus—RHYNCHONELLA, <i>Fischer</i> .				
<i>Rynchonella primipillaris</i> , <i>von Buch.</i> , Pl. 4, fig. 5 ... ..	...	x		
Genus—PENTAMERUS, <i>J. Sowerby</i> .				
<i>Pentamerus breirostris</i> , <i>Phillips</i> , Pl. 37, figs. 6, 9-11 ... ..	...	x		
Family—STRINGOCEPHALIDÆ.				
Genus—STRINGOCEPHALUS, <i>DeFrance</i> .				
<i>Stringocephalus</i> ? <i>sp. ind.</i> ... ..	...	x		
Family—STROPHOMENIDÆ.				
Genus—ORTHOTETES, <i>Fischer</i> .				
<i>Orthotetes umbraculum</i> , <i>Schl.</i> ... ..	...	x		
„ ? <i>concentrica</i> , <i>Eth. fil.</i> ... ..	...	x		
Class—CEPHALOPODA.				
Order—TETRABRANCHIATA.				
Family—NAUTILIDÆ.				
Genus—GYROCERAS, <i>De Koninck</i> .				
<i>Gyroceras Philpi</i> , <i>Eth. fil.</i> , Pl. 4, figs. 6, 7 ... ..	...	x	...	x

In the above list we have a fairly representative collection, with a decided preponderance of Middle Devonian forms. It will be seen that not a single fossil hitherto collected is specifically identical with any which are known in the Permo-Carboniferous System. Three genera of Actinozoa, viz., *Favosites*, *Pachypora*, and *Cyathophyllum*, and two of Brachiopoda, viz., *Spirifera* and *Rhynchonella*, are, however, repeated in the Gympie Formation; and the two Brachiopods above named are also repeated in the Star Formation. *Spirifera* alone survives in the Middle Bowen Formation.

The Queensland Devonian may be fairly placed on the same horizon as the Middle Devonian Limestones of Bindi and Buchan, Victoria,\* and is probably on a lower horizon than the Upper Devonian of Tynana Creek, Victoria. My Colleague informs me that the Lower Devonian age ascribed to various rocks in New South Wales is doubtful, and that all the fossils from these rocks which have come under his notice are now believed to be Upper Silurian.

## MINES IN CONNECTION WITH THE MIDDLE DEVONIAN ROCKS.

### ARGENTINE SILVER FIELD.

The argentiferous lead lodes of the Argentine Field occur partly in granite country and partly among highly inclined micaceous clay-slates, mica-schists, and gneisses. Regarding the age of the sedimentary rocks above referred to, no distinct evidence has yet been brought to light, but from their position between the Broken River and Reid, they may be supposed to be continuous with the Middle Devonian rocks of these districts. A thick series of white sandstones, pebbly grits, and conglomerates, probably identical with the lower portion of the Star Formation, lies unconformably on the slates, &c., or rests on the granite.

The field has been in existence since 1881. The lodes, especially those in the mica-schist country, offer every indication of richness and permanence; fuel and limestone and ironstone for fluxing are abundant and conveniently situated. In spite of all these advantages, prosperity has hardly yet dawned on the field. The majority of the lodes were originally secured as freeholds under the old Mineral Lands Act, the workings being for a time of a very perfunctory nature and having for their object the bare fulfilment of the "improvement conditions," or the raising of sufficient specimens to induce outsiders to purchase the mines. Some of the mines, worked on a "poor man's" scale, have obviously failed through the mechanical difficulty of separating earthy low-grade oxide and carbonate ores from the almost equally heavy ferruginous gangue-stuff without dressing machinery. The failure of the smelting works, which were erected prematurely, before sufficient quantities of ore were ready for them, was a severe blow, destroying as it did confidence in the value of the mines, and bringing about their almost complete desertion. The Hero and Northbrook Mines have, however, been steadily worked at a profit for some years, the ores being shipped from Townsville. The Hero has recently been taken up by a Sydney company.

The surface ores, which have alone been raised hitherto, consist for the most part of oxides, carbonates, sulphates, and sulphides of lead. The silver contents of samples which I have assayed average generally about  $1\frac{1}{2}$  oz. per ton to the unit of lead, but occasionally reach 5 oz. of silver to the unit. In other words, a ton of galena ore containing 60 per cent. of lead might contain from 75 oz. to 300 oz. of silver.

There can be no doubt that this field will yet take a high place among the silver-producing localities of Australia.

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\* *Geology and Physical Geography of Victoria*, by Reginald A. F. Murray. Melbourne: by Authority: 1887, p. 53.

As the Argentine Field was only occasionally visited by the Warden from Ravenswood, the returns of the output as given in the Annual Reports of the Department of Mines only give occasional references to quantities of ore exported. The following are all the particulars obtainable from this source:—

1883	...	...	10 tons exported	...	Value, £20
1884	...	...	20 "	...	" 225
1885	...	...	20 "	...	" 600
1887	...	...	40 " produced	...	" 680
1888	...	...	50 "	...	" 1,000
1889	...	...	76 "	...	" 3,354

Three exporters of ore have supplied me with the following returns of ore which passed through their hands during a portion of the time covered by the existence of the field:—

Date.	Exporters.	Quantity of Ore.	Value at the Mines.	ANALY.		
				Lead.	Silver.	Gold.
		Tons cwt. qr. lb.	£ s. d.	Per cent.	Oz. per ton.	Oz. per ton.
May, 1883...	L. Ryan ...	3 10 0 0	165 0 0	...	...	...
May, 1887...	Ditto ...	1 0 0 0	55 0 0	...	...	...
Jan. 1, 1884 to Jan. 1, 1888	Hays and Bundoek ...	200 0 0 0	1,600 0 0	...	...	...
June, 1885...	Allen and Sons* ...	3 3 0 0	39 8 0	...	101·26	0·327
July, 1885...	Ditto ...	3 15 0 0	46 0 0	...	98	0·337
Aug., 1885...	Ditto ...	6 14 2 26	31 0 0	30	60·43	1·47
June, 1886...	Ditto ...	9 15 0 0	153 0 0	43	84	...
May, 1887...	Ditto ...	3 5 1 16	29 0 0	43	85	...
June, 1887...	Ditto ...	3 1 0 16	17 16 0	33	64	...
July, 1887...	Ditto ...	6 5 2 8	27 16 0	20	57	...
Aug., 1887...	Ditto ...	4 1 0 0	21 16 0	64	27	...
Dec., 1887...	Ditto ...	5 10 0 0	8 4 3	21	41	...
Jan., 1888...	Ditto ...	3 6 1 0	12 11 4	22	53	...
Totals	...	298 17 0 10	2,206 11 7	...	...	...

\* Messrs. Allen and Sons' returns give the amount received for the ore in England, less £1 per ton for freight. From these I have deducted £1 per ton for carriage to port and other expenses.

J.

## CHAPTER V.

### THE ORGANIC REMAINS OF THE MIDDLE DEVONIAN (BURDEKIN) FORMATION,

#### WITH DESCRIPTIONS OF THE SPECIES.

IN the Devonian Series of Queensland there are at least four well-marked fossiliferous horizons, the three last of which may possibly be merely extensions of one deposit. They are:—

- Limestones of the Broken River.
- „ „ Burdekin Downs.
- „ „ Fanning River.
- „ „ Reid Gap, near Townsville.

The Organic Remains derived from the three horizons above named are almost wholly corallian; a few Brachiopoda from the Fanning Limestone, and one Cephalopod from the Reid Gap Limestone completing the list, with the exception of a plant—*Dicranophyllum australicum*, Dawson—occurring both in a calcareous shale forming the upper portion of the Fanning Limestone, and the lowest beds of the suprajacent sandstone.

The Burdekin Downs Limestone has yielded:—

- Stromatopora*, *sp. ind.*
- Pachypora meridionalis*, N. and E. fil.
- Alveolites robustus*, Rom.
- „ *sp. ind.*
- Trachypora*, *sp. ind.*
- Aræopora australis*, N. and E. fil.
- Heliolites porosa*, Goldf.
- Aulopora repens*, E. and H.

The Fanning Limestone has yielded:—

- Dicranophyllum australicum*, Dawson.
- Pachypora meridionalis*, N. and E. fil.
- Striatopora* ? *uniseptata*, Eth. fil.
- Heliolites porosa*, Goldf.
- Spirifera curvata*, Schl.
- „ *curyglossa*, Schnur.
- Atrypa reticularis*, Linn.
- „ *desquamata*, J. de C. Sow.
- Rhynchonella primipilaris*, V. Buch.
- Pentamerus brevirostris*, Phill.
- Stringocephalus* ? *sp. ind.*
- Orthotetes umbraculum*, Schl.
- „ *concentrica*, Eth. fil.
- Gyroceras Philpi*, Eth. fil.

From the Broken River Limestone we have :—

- Stromatopora*, *sp. ind.*
- Favosites gothlandica* (Foug.), Lamk.
- Heliolites porosa*, Goldf.
- „ *Daintreei*, Eth. fil. and N.
- „ *plasmoporoides*, Eth. fil. and N.
- „ *Nicholsoni*, Eth. fil.
- Amplexus*, *sp.*
- Crinoid stems.

The Reid Gap Limestone has yielded :—

- Stromatopora*, *sp. ind.*
- Pachypora meridionalis*, N. and E. fil.
- Alveolites alveolaris*, De Kon.
- „ „ *var. queenslandensis*, Eth. fil. and Foord.
- Amplexopora* ? *Koninckii*, Eth. fil. and Foord.
- Romingeria* ? *Foordi*, Eth. fil.
- Cænites*, *sp.*
- Aulopora*, *sp. ind.*
- Cystiphyllum americanum*, E. and H., *var. australe*, Eth. fil.
- Cyathophyllum*, *sp. ind.*
- Campophyllum Gregorii*, Eth. fil.
- Gyroceras Philpi*, Eth. fil.

The age of these beds appears to be fairly marked out. “The Fanning River Limestone and its associated shale have been shown to possess a strong claim to be considered Devonian. We have determined only two corals satisfactorily from this horizon, *Heliolites porosa* and *Pachypora meridionalis* (nobis). The former, a typical Devonian coral in Devonshire and the Eifel, supports the evidence afforded by the mollusca in a marked degree; that of the *Pachypora* will be considered immediately.

“We now come to the two localities, both in the Burdekin district—a limestone developed on the Broken River and Arthur’s Creek, Burdekin Downs. The first point to be noticed in connection with these localities is the presence of massive *Favosites* of the Devonian type, quite undistinguishable from the *F. gothlandicus* and its variety *F. Goldfussi*, of the Devonian of Europe and North America. Secondly, we note the presence of numerous large colonies of *Heliolites*, including *Heliolites porosa* in abundance.

“Again, strong evidence of a Devonian age is afforded by the appearance here of a coral which we cannot distinguish from *Aulopora repens*, Edw. and H., a very characteristic Devonian species of the equally characteristic Devonian genus *Trachypora*; while species of *Alveolites* of a Devonian type are also present. Hardly less characteristic is the *Pachypora* to which we have given the name of *P. meridionalis*, and which is most intimately allied to *P. cervicornis*, De Blainv., *sp.*, of the Devonian of Europe, and to similar or identical forms in the Devonian of North America.”\*

Lastly, in the Reid Gap Limestone we again find *Pachypora meridionalis* and *Heliolites* in abundance, together with *Stromatopora*, and the characteristic genus *Cystiphyllum*, represented by a species of a markedly Devonian aspect, and other Rugose corals indicating a similar horizon. “Upon the whole, therefore, putting to the evidence afforded by the corals, that derived from such characteristic forms as *Stromatopora* and *Caunopora*, we cannot doubt that the deposits now under consideration are

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\* Nicholson and Etheridge junr., Ann. and Mag. Nat. Hist., 1879, vol. iv., p. 234.

of Devonian age. So far as we are acquainted with their fauna, they would seem to correspond very closely with the Middle Devonian Limestones of the Eifel, or perhaps with the somewhat older series of the Corniferous Limestone of North America." In other words, the series of rocks in question may be said to homotaxially represent those formations. They are certainly not of Upper Devonian age, and there is no evidence to assign them a position in the Upper Silurian. The Brachiopoda so far obtained favour this view, and there is a marked absence of the large *Pentameri*, *Strophomena*, and Crinoids which are usually the most marked objects in an Upper Silurian Fauna.

## DESCRIPTION OF THE SPECIES.

### Kingdom—PLANTÆ.

#### Section—PHANEROGAMOUS PLANTS.

##### Class—EXOGENÆ.

##### ? Order—CONIFERÆ.

*Genus—DICRANOPHYLLUM*, *Grand'Eury*, 1877.

(Mem. Acad. Sci. Inst. France, xxiv., p. 272.)

*DICRANOPHYLLUM AUSTRALICUM*, *Dawson*, Pl. 4, fig. 13.

*D. australicum*, *Dawson*, Quart. Journ. Geol. Soc., 1881, xxxvii., p. 306, t. 13, f. 15.

*Sp. Char.* The leaf bases are minute, narrow, elongate, and spirally arranged; the leaves are linear and bifurcating at an obtuse angle at their extremities.

*Obs.* This is the only plant yet found in the Devonian rocks of Queensland. Sir J. W. Dawson appears to regard it as Corniferous.

*Loc. and Horizon.* Fanning River, Burdekin Downs, in a calcareous shale forming the upper portion of the Fanning Limestone, and in white flaggy sandstone overlying the same limestone. (*R. L. Jack.*)

### Kingdom—ANIMALIA.

#### Sub-Kingdom—CŒLEENTERATA.

##### Class—HYDROZOA.

##### Order—HYDROCORALLINÆ.

##### Family—STROMATOPORIDÆ.

*Genus—STROMATOPORA*, *Goldfuss*, 1826.

(*Petrefacta Germaniæ*, p. 21.)

*STROMATOPORA*, *sp. ind.*, Pl. 1, figs. 3-5.

*Obs.* *Stromatopora* occurred amongst Mr. Daintree's fossils from the Broken River Limestone, but in so highly silicified a state that a satisfactory examination of the specimen could not be made. Another example has been forwarded by Mr. Jack from the Arthur's Creek Limestone, which is very like some Devonian species of Devonshire and the Eifel.

Much more satisfactory and massive examples occur in the Reid Limestone, enveloping the various corals which constitute that rock. Prof. H. A. Nicholson, M.D., who was kind enough to examine specimens, at one time believed them to be a *Pachystroma*, allied to *P. densum*, Nich. and Murie; but a subsequent inspection, since

he has been engaged on his "Monograph of the Stromatoporidæ," has led him to regard the masses in the Reid Limestone as more probably referable to *Stromatopora* proper, and even allied to the typical and true *S. concentrica*, Goldf., and *Stromatoporella* (Pl. 1, figs. 1, 2). The surfaces of many of these large masses from the Reid Limestone present mammillary or button-shaped prominences, which have been left by the process of weathering, possessing, however, the same structure as the general mass. They may be merely the result of peculiar preservation, or they may be young examples included in the older ones; at any rate, so far as we can at present ascertain, they do not appear to have any specific value.

Pending a detailed and proper description of the Eifel and Devonshire forms of *Stromatopora*,\* I refrain from entering into details concerning these specimens, and hope to be able to do so, with more satisfactory material, at some future date.

*Loc. and Horizon.* Broken River, a tributary of the Clarke River (*The late R. Daintree*); Terrible or Arthur's Creek, Burdekin Downs (*R. L. Jack*); and Regan's, Northern Railway, thirty-one miles from Townsville, Reid Limestone (*R. L. Jack*).

### Class—ACTINOZOA.

The three groups of the Zoantharia, Alcyonaria, and Rugosa are represented in the Devonian of Queensland—the first by the genera *Favosites* and *Alveolites*, &c., the second by *Aulopora*, *Amplexopora*, &c., and the last-named by the genera *Cyathophyllum*, *Campophyllum*, and *Cystiphyllum*. The examination of all these corals is rendered difficult, as in the case of the *Stromatoporoidea*, by their highly altered condition. No doubt a further examination of the localities mentioned will bring to light a much more copious coral fauna than that here described.

### Order—ZOANTHARIA.

#### Sub-Order—Z. SCLERODERMATA.

##### Section—PERFORATA.

##### Family—FAVOSITIDÆ.

##### Genus—FAVOSITES, Lamarck, 1816.

(Hist. Anim. sans Vertèb., ii., p. 204.)

*Obs.* Amongst the Queensland corals are two forms of *Favosites* only separable by the size of the corallites composing the respective colonies. These are referred to the cosmopolitan *Favosites gothlandica*, and its variety *Goldfussi*.

A single specimen of a massive *Favosites* with plenty of tabulæ was obtained at Raglan, Port Curtis, by Mr. W. H. Rands. It is preserved in a light slate-blue conchoidal limestone and has a strong Devonian aspect. The material was not sufficient in quantity to permit of the preparation of sections for a specific determination.

##### FAVOSITES GOTHLANDICA, (Foug.) Lamarck, Pl. 3, figs. 1-5.

*Favosites gothlandica*, Lamarck, Hist. Anim. sans Vertèb., 1816, ii., p. 206.

*Calamopora gothlandica*, Goldfuss, Petrefacta Germaniæ, 1829, i., p. 78, t. 26, fig. 3 a-e.

*Favosites gothlandica*, Edwards and Haime, Polyp. foss. Terr. Pal., 1851, p. 232.

*Favosites Goldfussi*, Edwards and Haime, *ibid.* p. 235, t. xx., fig. 3 a, b.

*Favosites gothlandica*, Nicholson and Etheridge fil., Ann. Mag. Nat. Hist., 1879, iv., p. 209.

*Favosites gothlandica*, Nicholson, Tab. Corals Pal. Period, 1879, p. 46, t. i., figs. 1-6.

*Obs.* It will be convenient to consider the form with the smallest corallites (Pl. 3, fig. 4), as the typical *F. gothlandica*, whilst that with the larger calices may be

\* Now in course of preparation by Prof. H. A. Nicholson, and publication by the Palæontographical Society.



looked upon as the variety *Goldfussi* (Pl. 3, fig. 1). It has been repeatedly explained that Edwards and Haime regarded *F. gothlandica* as an essentially Silurian species; and the corresponding Devonian form was separated by them under the name of *F. Goldfussi*. The latter is stated by its authors to be distinguished from the former by its larger corallites and more closely set mural pores. The size of the tubes ( $1\frac{1}{2}$  lines), however, is frequently exceeded by typical Upper Silurian examples of *F. gothlandica*, notwithstanding their more commonly smaller size. Under any circumstances, the size of the corallites merely cannot be regarded as a character of the smallest specific value, while the mural pores exhibit an at least equal variability. Upon the whole, therefore, *F. Goldfussi*, Edw. and H., cannot be satisfactorily separated from *F. gothlandica*, except as a mere variety.

In the specimens here referred to, *F. gothlandica*, var. *Goldfussi*, the diameter of the calices, as before stated, is about  $1\frac{1}{2}$  lines, in extreme cases reaching as much as  $2\frac{1}{2}$  lines. In one example there are four tabulæ in the space of 2 lines vertical, whilst in another specimen the same number are contained in a space a little exceeding this. The examples collected by the late Mr. Daintree appear to be only portions of colonies; but notwithstanding this, one of the specimens, a very fine one, measures  $9\frac{1}{2}$  by  $4\frac{1}{2}$  inches, forming a more or less elongated depressed parallelogram. This form of *F. gothlandica* corresponds in a striking manner with that met with in the Corniferous Limestone of North America, a careful comparison having been made with colonies of the latter coral in the cabinet of one of us.

We now come to four specimens, and possibly a fifth, which are regarded as referable to *Favosites gothlandica* proper, as understood by Messrs. Edwards and Haime. They also bear a close resemblance to *F. epidermata*, Röminger, from the Corniferous Limestone of North America, which is probably, after all, only another variety of the widely spread and typical *F. gothlandica*. In the colonies in question the calices are much smaller, scarcely ever exceeding 1 line in diameter, and frequently less, whilst four tabulæ appear, on an average, to be comprised within the space of  $1\frac{1}{2}$  lines vertical. We say on an average, because we find, on the examination of a sufficiently large number of specimens gathered from various quarters, and including those from Australia, that there is every gradation between the two conditions in the size of the corallites and disposition of the tabulæ. It is on these grounds, combined with the variable disposition of the mural pores, that we propose to consider *F. gothlandica* in the wide sense understood by Goldfuss, before its subdivision by Edwards and Haime.

In the fifth example, previously referred to as probably identical with the other form, the septal spines are well developed. (*Nicholson and Etheridge fil.*)

*Loc.* Broken River, a tributary of the Clarke River (*The late R. Daintree*, Collection British Museum, and Geological Survey of Queensland). A small fragment of *Favosites*, probably *F. gothlandica*, has been more recently obtained by Mr. Jack from the above locality.

#### Genus—*PACHYPORA*, Lindström, 1873.

(Ofver. K. Akad. Förhandl., 1873, p. 14.)

*PACHYPORA MERIDIONALIS*, Nich. and Eth. *fil.*, Pl. 2, figs. 10-15.

*P. meridionalis*, Nich. and Eth. *fil.*, Ann. and Mag. Nat. Hist., 1879, iv., p. 280.

*Sp. Char.* Corallum ramose, of cylindrical branches, about  $2\frac{1}{2}$  lines or 3 lines in diameter, dividing dichotomously at comparatively remote intervals. Corallites not regularly polygonal, with very thick walls, the diameter of which increases as the mouth is approached. Calices hardly at all oblique, about a third of a line, or sometimes rather more, in diameter, oval, rounded, or irregular in shape, often

opening into one another, surrounded by thick obtuse margins, which exhibit no traces of the original polygonal wall of the corallite. Mural pores few, very large, and irregularly placed. Tabulæ few and remote. (*Nicholson and Etheridge fil.*)

*Obs.* This species is unquestionably very closely allied to *Pachypora cervicornis*, De Blainv., of the European Devonian, and we have felt some hesitation in giving it a distinct specific designation. Both belong to that section of *Favosites* in which the walls are thickened by the secondary deposition of sclerenchyma in successive laminæ, the amount of this thickening being increased as the mouth is approached, and are therefore referable to Lindström's genus *Pachypora*. Both are alike in form and general habits, and have singularly large, sparse, and irregular mural pores. After a comparison, however, of the Australian specimens with examples from the Eifel, macroscopically and microscopically, we have come to the conclusion that the former must, in the meanwhile, be regarded as specifically distinct, upon the following grounds:—

- (a) *Pachypora meridionalis* (nobis), is, on the whole, a much smaller species than *P. cervicornis*, De Blainv., the branches in the latter often reaching 8 or 10 lines in diameter.
- (b) The corallites in *P. cervicornis* can always be shown, by thin sections, to preserve their polygonal outline, in spite of the thickening to which they are subjected; in the axis of the branches they are regularly polygonal, and even the thickened lips of the calices show more or less distinctly a polygonal line placed at a little distance from the mouth of the tube, which represents the original wall. On the other hand, in *P. meridionalis* the polygonal form of the corallites is more or less completely obliterated; even in the axis of the branches the originally prismatic wall cannot be detected, and the thickened lips of the calices are simply rounded and obtuse.
- (c) In *P. cervicornis* the calices are about half-a-line in diameter, rounded or sub-polygonal, and only occasionally opening into one another. In *P. meridionalis*, on the contrary, the calices are mostly only about a third of a line in diameter (counting in, as before, the wall around them); their shape is very irregular, and they open into one another so frequently, and to such an extent, that they sometimes become almost vermiculate in character.

Upon the whole, therefore, the present species is sufficiently distinct from *P. cervicornis*, De Blainv., to deserve a separate name, and we know of no other adequately characterised species with which it is necessary to compare it in detail. We may add that the differences between *P. meridionalis* and *P. cervicornis*, above alluded to, are much more conspicuous if we take specimens of the form usually known by the latter name in the Devonian Limestones of Devonshire, and figured as such by Milne-Edwards and Haime.\* (*Nicholson and Etheridge fil.*)

*Loc.* Fanning River, Burdekin Downs, and Arthur's Creek, Burdekin Downs; Regan's, Northern Railway, thirty-one miles from Townsville. (*R. L. Jack.*)

### Genus—*ALVEOLITES*, Lamarck, 1801.

(Emend. Nicholson, 1879.)

*Alveolites*, Lamk., Syst. Anim. sans Vertéb., 1801.

„ Nicholson, Tabulate Corals Pal. Period, 1879, pp. 117, 375.

*Billingsia*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1876, Pts. 1, 2, p. 75.

*Cladopora*, Rominger, Report Geol. Survey Michigan, 1876, iii., Pt. 2, p. 50.

*Obs.* The chaotic condition in which the genus *Alveolites* remained for many years has been commented on, and the genus made the subject of research by Prof.

\* Mon. Brit. Dev. Corals, Pl. xlviii., fig. 2.

H. A. Nicholson, and the Writer,\* and later by the former alone. As now restricted it contains Favositiform corals with thin-walled corallites opening obliquely on the surface by sub-triangular or semi-lunar calices. The septa are either obsolete or in the form of longitudinal rows of spinules. It has been already pointed out by Mr. A. H. Foord and the Writer † that the species upon which De Koninck's genus *Billingsia* was founded is a true *Alveolites*, and it follows, therefore, that *Billingsia* must now be considered a synonym of the latter. Previous to this determination, Prof. H. A. Nicholson had remarked, ‡ "It seems hardly possible, with our present knowledge, to arrive at any certain conclusions as to its true systematic position" (i.e., of *Billingsia*).

*Cladopora*, Hall, as defined by Röminger, § does not appear to differ essentially from *Alveolites*. The corallites are said to be usually devoid of tabulæ, but Röminger observes—"Their occasional development is proved by many actual observations."

Under this name there have been described from the Palæozoic rocks of Australia the following species:—The Upper Silurian Series of Burrowang has yielded to the researches of Prof. De Koninck, || *Alveolites repens*, Foug., and *A. rapa*, De Kon. The so-called Lower Devonian rocks of the same Colony have yielded *Alveolites subæqualis*, Edw. and H., and *A. obscurus*, De Kon. The Queensland *Alveolites* in no way correspond to any of these; indeed, the two new species described by Prof. De Koninck appear to be very unsatisfactorily established, and nothing is known of their microscopic structure.

In addition to the foregoing, Prof. H. A. Nicholson and the Writer described two imperfectly known species in 1879.

#### ALVEOLITES ALVEOLARIS, *De Koninck*, sp., Pl. 2, figs. 1-3a.

*Billingsia alveolaris*, De Kon., Foss. Pal. Nouv.-Galles du Sud, 1876, Pts. 1-2, p. 75, t. 2, f. 4 a, b.

*Alveolites alveolaris*, Eth. fil. and Foord, Ann. and Mag. Nat. Hist., 1884, xiv., p. 176, t. 6, f. 1-1c.

*Sp. Char.* Corallum massive and apparently lobate. Corallites minute (about two in the space of a millim.), closely contiguous, of considerable length and their walls somewhat thick; the apertures of the calices present an irregularly lunate form, and in some of them a single tooth-like septum may be detected. Tabulæ well developed, horizontal, or a little curved and tolerably numerous. Mural pores large, in a single series placed at pretty regular intervals of about half a millimeter apart.

*Obs.* The highly crystalline condition of the specimens rendered their determination very difficult. They occur in the shape of weathered masses in which some parts, harder than the rest, stand out in relief and exhibit well the structures described above. One of the specimens has the surface studded with small conical elevations, about 1 centimeter apart, measured from their summits. The significance of these is not apparent, and their occurrence is not known in any species of *Alveolites*. Of the two species of *Alveolites* recorded from Australian Devonian rocks, only one (*A. subæqualis*, Ed. and H.) need be compared with the present form, and the much smaller corallites of the latter afford sufficient grounds for their separation.

In his "Palæozoic Fossils of New South Wales," Prof. L. G. De Koninck instituted a genus under the name of *Billingsia*, for a Devonian coral from the neighbourhood of Yass, which the author describes as apparently devoid of tabulæ ("Les planchers semblent faire défaut") and as possessing lateral openings in the walls of the corallites resembling those of *Syringopora*. M. De Koninck appears to have

\* Journ. Linn. Soc. (Zool.), xiii., p. 353.

† Ann. and Mag. Nat. Hist., 1884, xiv., p. 176.

‡ Tabulate Corals Pal. Period, 1879, p. 186.

§ Report Geol. Survey Michigan, 1876, iii., Pt. 2, p. 50.

|| Foss. Pal. Nouv.-Galles du Sud, 1876, Pt. 1, pp. 17, 18, 19.

entirely misunderstood the structure of this coral. The figures given by that Author accord remarkably well with our form; and although he states in his description that tabulæ are wanting, they appear to be shown clearly enough in Fig. 4 of his work, as cited. Assuming, then, that *Billingsia alveolaris* is identical with the Queensland specimens, it is impossible to accept De Koninck's suggestion that the present species is transitional between *Aulopora* and *Syringopora*.

*Loc.* Regan's, Northern Railway, thirty-one miles from Townsville. (*R. L. Jack.*)

**ALVEOLITES ALVEOLARIS, var. QUEENSLANDENSIS, Eth. fil. and Foord, Pl. 2, figs. 4-6.**

*Alveolites alveolaris*, var. *queenslandensis*, Eth. fil. and Foord, Ann. and Mag. Nat. Hist., 1884, p. 177, t. vi., f. 2 a, b.

*Obs.* This form differs from that described above, chiefly in the size of the corallites, which are considerably larger than those of *A. alveolaris*. It also appears to be branching and lobulate, and occurs in large weathered and rounded fragments, one of which measures about 12 centimeters in its greatest length, and about 6 centimeters in thickness, but the specimen must have been considerably larger when perfect. Scarcely any of its surface remains, and microscopic sections do not yield very satisfactory results on account of the extensive mineral alteration that the fossils have undergone.

In their longer diameter the corallites measure about two-thirds of a millimeter, in their shorter about one-third or even less. The tabulæ are somewhat numerous, horizontal or oblique, and sometimes curved, and in some places they anastomose. The mural pores are large and apparently numerous.

*Loc.* Regan's, Northern Railway, thirty-one miles from Townsville. (*R. L. Jack.*)

**ALVEOLITES ROBUSTUS, Röminger, Pl. 1, figs. 13, 14.**

*Cladopora robusta*, Röminger, Report Geol. Survey Michigan, 1876, iii., Pt. 2, p. 55, t. 22, f. 1, 2.

*Obs.* A ramose species, with affinities to *Pachypora*, and possibly really referable to this latter genus. The surface characters are much destroyed by weathering, and as its internal structure shows nothing but mural pores and tabulæ, with no special features of interest, little further can be said about it. The coral may at once be distinguished from *Pachypora meridionalis* by its very oblique tubes and calices.

The largest of the specimens hitherto examined (by no means a perfect one) is  $3\frac{1}{2}$  inches in length. The distance between two points of bifurcation or dichotomization of the branches is 1 inch 3 lines.

This species is very like *Alveolites (Cladopora) robustus*, Röm., and so closely resembles his smaller figure of that form that one is induced to refer it to the latter, even without an actual comparison of specimens. The Queensland examples possess the same habit of growth as those from Michigan, and the calices correspond in size with the figures indicated. *Alveolites robustus*, Röm., is met with both in the Corniferous and Hamilton Groups (Lower and Middle Devonian) of North America.

*Loc.* Arthur's Creek, Burdekin Downs. (*R. L. Jack.*)

**ALVEOLITES, sp. ind., Pl. 1, figs. 15-17.**

*Alveolites*, sp. ind., Nicholson and Eth. fil., Ann. and Mag. Nat. Hist., 1879, iv., p. 222.

*Obs.* An expanded, lobate, or palmate form, which, in the present unsatisfactory and chaotic state of *Alveolites*, is very difficult to determine, although, specifically speaking, we do not know anything precisely like it. Sections show that the corallites were thin-walled and irregular, with mural pores and plenty of tabulæ. With the meagre material before us, it would be only unnecessarily increasing nomenclature to bestow a name. (*Nicholson and Etheridge fil.*)

*Loc.* Arthur's Creek, Burdekin Downs. (*R. L. Jack.*)

Genus—*AMPLEXOPORA*, Ulrich, 1882.

(Journ. Cincinnati Soc. Nat. Hist., v., p. 154.)

*AMPLEXOPORA*? KONINCKII, Etheridge fil. and Foord, Pl. 2, figs. 7-9a.

*Amplexopora Koninckii*, Eth. fil. and Foord, Ann. and Mag. Nat. Hist., 1884, xiv., p. 178, t. 6, f. 3 a-c.

*Sp. Char.* Corallum massive. Calices polygonal in outline, with the angles rounded, minute and variable in size, somewhat thin-walled; from three to four occupy the space of 1 millimeter. Spiniform corallites placed at the angles of junction of many of the cell apertures. Tabulæ remarkably regular, horizontal, from 1 to 2 tube diameters apart.

*Obs.* The present species, like the others from the same locality, has undergone a good deal of alteration by weathering and crystallisation, so as to obscure, in a measure, the structure of the organism. The in-filling of the coral is calcite of fibrous structure (Arragonite?), the fibres cutting the walls of the corallites, as well as crossing the visceral cavities.

The first impression gained on examining thin sections of this coral was that it might be a *Chonetes*; but the presence of the spiniform corallites (provided, of course, these structures have been correctly interpreted), sets this question at rest.

*Loc.* Began's, Northern Railway, thirty-one miles from Townsville. (R. L. Jack.)

Genus—*TRACHYPORA*, Edw. and Haime, 1851.

(Polyp. Foss. Terr. Pal., p. 305.)

*TRACHYPORA*, *sp. ind.*

*Trachypora*, *sp. ind.*, Nicholson and Eth. fil., Ann. and Mag. Nat. Hist., 1879, iv., p. 281.

*Obs.* A single and badly preserved example has occurred in the Arthur's Creek Limestone, which, although sufficiently good for generic identification, is in too ill-preserved a condition to warrant us in attaching to it a specific description and name.

The specimen is seated on the weathered surface of a piece of limestone, and exhibits the vermiculate surface and non-septate calices characteristic of *Trachypora*.

*Loc.* Arthur's Creek, Burdekin Downs. (R. L. Jack.)

Genus—*STRIATOPORA*, Hall, 1852.

(Pal. New York, ii., p. 156.)

*STRIATOPORA*? UNISEPTATA, *sp. nov.*, Pl. 37, figs. 1, 2.

*Sp. Char.* Corallum small, dendroid, composed of bifurcating cylindrical stems. Corallites thick-walled, the calices arranged in vertical rows separated by thickened sclerenchyma, with oval, oblique, cup-shaped apertures, of more or less equal dimensions; the orifices below are circular and contracted, the distal wall invariably bearing a single septal ridge. Pores small, not numerous, scattered. Tabulæ?

*Obs.* In some respects this little coral resembles *Striatopora*, as in the arrangement of the cells, and the form of their orifices. On the other hand, it differs widely in the separation of the former by the interstitial cœnenchyma, and in the presence of a single septum only; in fact, I much question the propriety of retaining it in this genus. The single septum is a very constant character in each calice, as a vertical ridge on the distal, on hinder wall, apparently descending far into the former.

I have not observed any definite trace of tabulæ, the material being too limited in quantity to permit of the preparation of microscopic sections. In the weathered portion of the specimen these delicate organs have been removed. Judging from a natural transverse section the corallites seem to have had well-developed walls in the centre of the corallum. and to pass outwards by a very gentle and gradual curve.

The poriferous nature of the walls clearly indicates this as a member of the Favositidæ, although it is quite possible that it may be referable to a genus other than *Striatopora*.

A similar septal tooth occurs in a French Devonian fossil, *Trachypora marmorea*, Gosselet.\*

*Loc.* Fanning River. (*R. L. Jack.*)

*Genus*—*ROMINGERIA*, *Nicholson*, 1879.

(*Tabulate Corals Pal. Period*, p. 114.)

*ROMINGERIA* ? *FOORDI*, *sp. nov.*, Pl. 1, fig. 18.

*Sp. Char.* Corallum ramose. Corallites small, tubular, their outlines faintly indicated on the surface of the branches. Calices oval or circular, exsert or slightly disjunct, sub-opposite, sometimes contiguous, and almost touching one another.

*Obs.* It is quite an open question whether this coral should be placed in *Romingeria* or *Vermipora*, but probably in one or the other, notwithstanding its ramose character. Although the surface is much weathered, the tubular outline of the corallites is dimly portrayed on the branches, and this would to some extent ally it to the still more divided-up corallum of one or other of the above genera. At the broken distal end of the specimen the tubular state of the corallites is quite apparent.

The surface is too much weathered to show the annulations described by Prof. Nicholson in his genus, even if they existed, and, from the same cause in all probability, septa are not visible.

Named in honour of Mr. A. H. Foord, late of the Geological Survey of Canada, with whom the Writer has been engaged in palæontological investigation.

*Loc.* Reid Gap, thirty-one miles from Townsville. (*R. L. Jack.*)

*Genus*—*CÆNITES*, *Eichwald*, 1829.

(*Zoologia Spec.*, I., p. 179.)

*Obs.* *Cænites* is represented by a few ramose or frondescant specimens, with the general aspect of *Cænites expansus*, De Koninck (Pl. 2, figs. 18 and 19), the mouths of the calices corresponding in size and shape, but there are usually present three instead of two septal teeth. The specimens are not sufficiently well preserved for accurate determination.

*Loc.* Regan's, Northern Railway. (*R. L. Jack.*)

#### Family—PORITIDÆ.

*Genus*—*ARÆOPORA*, *Nicholson and Etheridge fil.*, 1879.

*Aræopora*, Nicholson and Eth. fil., *Ann. and Mag. Nat. Hist.*, 1879, iv., p. 277.

„ Nicholson, *Tabulate Corals Pal. Period*, 1879, p. 105.

„ Waagen and Wentzel, *Palæontologia Indica*, 1886, Ser. xiii., Pt. i., No. 6, p. 837.

*Gen. Char.* Corallum massive, resembling that of *Favosites*, of polygonal corallites, which radiate outwards from an imaginary axis to open upon the upper surface of the colony. Under surface covered with an epitheca (?). The corallites are firmly united by their walls, which are extensively pierced by apertures, placing the visceral tubes in direct communication. Septa trabecular, often irregularly divided or anastomosing at their free ends. Tabulæ rudimentary, represented by occasional horizontal trabeculæ. No columella nor cœnenchyma. (*Nicholson and Etheridge fil.*)

*Obs.* This genus was founded upon a single remarkable specimen belonging to the Daintree Collection, from the Devonian deposits of Queensland, distinguished specifically by the name of *Aræopora australis*.

\* *Ann. Soc. Géol. du Nord*, 1877, iv., t. 3, f. 2a.

Since the description of *Aræopora* by Prof. H. A. Nicholson and the Writer appeared, Messrs. Waagen and Wentzel have re-defined\* the genus from material obtained from the rich beds of the Salt Range in India, with the result that the "characteristic of the genus must be changed to a certain extent in some points to fit the Salt Range species." Several points in their observations appear to call for remark. In the first place *Aræopora* is ascribed to Nicholson alone, as given in his "Tabulate Corals," published in 1879. Messrs. Waagen and Wentzel appear wholly to ignore the heading which they quote from this work as given by Prof. Nicholson, viz., "*Aræopora*, Nich. and Eth. jun., 1879." Secondly, the above Authors appear to be unacquainted with, or to have overlooked the description of *Aræopora* given by Prof. Nicholson and the present Writer,† which, as a matter of fact, was published before the "Tabulate Corals," and is the original and first published description of the genus. Had this not been so we should have referred, in preparing our joint memoir, to Prof. Nicholson's work. Messrs. Waagen and Wentzel, in the third place, state—"No mention is made by Nicholson of the spongy condition of the walls of the corallites." Not in so many words, perhaps, but in the expression "porous condition of the walls," used both in the "Tabulate Corals" and in our joint Memoir, far more is implied than that the walls are merely pierced by mural pores. In addition, the figures gave an excellent idea of the spongy nature of the walls. Lastly, the Authors say—"Another point which has to be rectified is the condition of the tabulæ. They are well developed and quite distinct, not rudimentary, in the Indian species." What the tabulæ may be in the latter it would be presumptuous for us to say, in the absence of specimens; but although they may be well marked in the Indian species that does not prove them to be anything else than rudimentary in the Australian form. It is quite possible that amplification of the characters of our genus may be required—as is usually the case in the first descriptions of obscure fossils—but this hardly approaches the authoritative "rectification" imagined by Messrs. Waagen and Wentzel.

*Type.* *Aræopora australis*, N. and E. fil.

*ARÆOPORA AUSTRALIS*, *Nich. and Eth. fil.*, Pl. 3, figs. 6-9.

*Aræopora australis*, Nicholson and Eth. fil., Ann. and Mag. Nat. Hist., 1879, iv., p. 278, p. 279, f. 3 a, b.

" " Nicholson, Tabulate Corals Pal. Period, 1879, p. 167, f. 24 a, b.

*Sp. Char.* Corallum massive, pyriform, of considerable size, composed of polygonal or prismatic corallites which radiate outwards from an imaginary axis to open on the upper surface of the colony. Average diameter of the corallites from two-thirds to three-fourths of a line, no very small tubes being intercalated amongst those of ordinary dimensions. Walls amalgamated, irregularly cribriform. Septa variable in number, spiniform, or irregularly divided. Tabulæ rudimentary. (*Nicholson and Etheridge fil.*)

*Obs.* The corallum of *A. australis* might at first sight be readily taken for that of any of the larger and more massive species of *Favosites* (such as *F. hemisphericus*, Yand. and Shum.), though even to the naked eye the absence of distinct tabulæ and the cribriform or porous condition of the walls are striking features. Our only specimen is not perfect, and is not only completely silicified, but is thoroughly infiltrated with silica tinged with oxide of iron. Its height is rather more than 3 inches, and its greatest width something over 4 inches. Its form is pyriform, the narrow base having evidently been attached to some foreign body, while the under surface was almost certainly covered by an epitheca, of which no traces now remain. The calices

\* Palæontologia Indica, Ser. xiii., Pt. i., No. 6, Coelenterata, p. 837.

† Ann. and Mag. Nat. Hist., 1879, Vol. iv., p. 277.

must have opened over the whole of the upper surface, but none of them are preserved in the specimen now before us. The corallites radiate with a graduated divergence from the imaginary axis of the colony; and their form is regularly prismatic or polygonal, as in *Favosites*. This character, however, is much more perceptible by the eye, or when the surface is examined with a lens, than it is when thin sections are investigated under the microscope, as it is to some extent marked in the latter case by the broken and cribriform structure of the walls. Thin sections (Pl. 3, figs. 7 and 9), whether transverse or vertical, show that the walls of the tubes are extensively porous and cribriform, being pierced by numerous apertures, which place the visceral chambers in direct communication. Transverse sections also serve admirably to show the character of the irregular trabecular septa, some of which are simply spiniform, while others divide towards their inner extremities, or even unite with their neighbours by their free ends. Vertical sections show that the septa are upon the whole placed in longitudinal rows, and they exhibit occasionally horizontal trabeculæ (Pl. 3, fig. 9), which may be regarded as of the nature of rudimentary tabulæ.

From a consideration of the above characters it cannot be doubted that we have to deal, in *Aræopora*, with a genuine "Perforate" Coral, which, however, is closely related to the Favositidæ, and may be best placed in this family rather than in any of the more regular groups of the Perforata. By the characters of its walls and septa the genus presents certain alliances with the Poritidæ; but its general form and aspect are those of a *Favosites*; and the presence of rudimentary tabulæ would further confirm the view here taken. Among the genera of the Favositidæ, its nearest ally is to be found in the Lower Silurian genus *Columnopora*, Nich., which it nearly resembles in form and habit. It is distinguished from the latter, however, by the less regularly perforate character of its walls, by the rudimentary condition of its tabulæ, and by the irregularly dividing and trabecular septa. We are unable to institute any comparison between *Aræopora* and the Cretaceous genus *Koninckia*, E. and H., but the septa of the latter seem to be merely spiniform (six in number), and the tabulæ are said to be well developed and complete. (*Nicholson and Etheridge fil.*)

Messrs. Waagen and Wentzel have removed *Aræopora* from the Favositidæ and placed it in the Poritidæ. It is possible this step may be quite justifiable.

*Loc.* Burdekin River. (*The late R. Daintree*; Colln. Brit. Mus.)

## Order—RUGOSA.

### Family—CYSTIPHYLLIDÆ.

#### *Genus*—CYSTIPHYLLUM, *Lonsdale*, 1839.

(Murchison's Silurian System, p. 691.)

CYSTIPHYLLUM AMERICANUM, *Edw. and Haime*, var. AUSTRALE, var. nov., Pl. 3, figs. 13, 14.

*Obs.* Up to the present time we are not acquainted with any published species of *Cystiphyllum* from Australian Devonian rocks, but a species has been met with in the Silurian beds of Burrowang, New South Wales. The coral reefs at Regan's on the Northern Railway, however, have yielded several examples of a very elongate species, with a general resemblance to the British Devonian *C. vesiculosum*, Goldfuss, but the vesicles of the corallum are much too large. On the whole the corals appear to come nearest to the American form *C. americanum*, and for all practical purposes may be regarded as a variety of it. In only one example has any tendency to a funnel or cone shaped outline been observed, such as occurs in *C. senegalense*, Billings,\* but not

\* Canadian Journal, 1859, p. 137.



sufficiently so to render it in any way allied to the latter. The length of the corallum would also indicate *C. conifollis*, Hall,\* as an ally, but no indication of the epithecal swellings of the latter occur in our form.

*Loc.* Regan's, Northern Railway, thirty-one miles from Townsville. (*R. L. Jack.*)

*Genus*—*CYATHOPHYLLUM*, Goldfuss, 1826.

(*Petrefacta Germaniæ*, i., I Theil, p. 54.)

*CYATHOPHYLLUM*, *sp. ind.*, Pl. 3, figs. 11, 12.

*Obs.* A few turbinate corals are associated with the more numerous specimens of the last species, which appear referable to the genus *Cyathophyllum*. The small amount of material, however, for investigation, and the large number of species of this genus at present known, render the task of identification difficult.

The complete corallum is unknown, but it was short and conical, or turbinate, with numerous septa—at least fifty-four in number. They are long and almost straight, every alternate one extending to the centre of the calice, the others not beyond the outer vesicular zone; the longer or primary septa are more or less confusedly intermingled or slightly twisted at the centre, giving rise to a loosely vesicular structure. The interseptal loculi are filled with large vesicles, forming an outer vesicular zone, extending inwards for quite half the width of the corallum. The fossula is apparently absent.

This species is evidently of the same type of growth as *C. virgatum*, Hinde,† and may possibly be it, as the number of septa closely correspond.

*Loc.* Regan's, Northern Railway. (*R. L. Jack.*)

In Leichhardt's "Journal of an Overland Expedition in Australia,"‡ the Rev. W. B. Clarke described a coral from the Burdekin Limestone§ as *Cyathophyllum Leichhardtii*. His description is here appended, but unfortunately little or nothing can be made of it from a systematic point of view. The name might be deleted with advantage to Australian Palæontology. The description is as follows:—

"The most conspicuous fossil is a coral which appears to belong to the family of Cyathophyllidæ. The genus is perhaps new, but this the want of specimens with which to compare it does not allow me the means of verifying. It may, however, be classed provisionally as *Cyathophyllum*, to which in many respects it bears a great resemblance.

"Cells concavely cylindrical, not dichotomous (thus distinguished from Caryophyllia) grouped but separate, laterally if at all proliferous. Corallum beautifully stellular, formed by 30-35 slightly spirally curving or regular radiating lamellæ, which meet in a central point or overlap on a latitudinal axial line, and are divided by rectangular or outwardly convex and upwardly oblique dissepiments, which become occasionally indistinct or obsolete near the centre, thus not assuming the usual characteristic of *Cyathophyllum* but rather one of *Strombodes*.

"Surface longitudinally striated, the cellular structure being hidden in calcareous spar, the striæ formed by the coalescing lamellæ, which, at the extremities, seem to be occasionally denticulated owing to the matrix interrupting their passage to the edge. This resembles what takes place in some *Astræidæ*.

"The interior has more the features of *Acervularia* than *Cyathophyllum*, but there are patches of broken transverse septa in the rock which exhibit the features of the latter."

\* Pal. N. York, Illustrations of Devonian Fossils, 1876, t. 3, f. 3-9.

† Geol. Mag., 1890, vii. (3), p. 194, t. 8, f. 1 a, b.

‡ Journal of an Overland Expedition in Australia from Moreton Bay to Port Essington during the years 1844-45 (8vo., London, 1847), p. 212.

§ "About Lat. 19° 58' 11" S." [Probably Burdekin Downs. *R.L.J.*]

## Family—ZAPHRENTIDÆ.

Genus—*AMPLEXUS*, J. Sowerby, 1814.

(Min. Con., i., No. 13, p. 165.)

*AMPLEXUS*, *sp. ind.*, Pl. 37, figs. 15, 16.

*Obs.* A single fragment of an *Amplexus* from the Broken River Limestone has some relation to *A. Selwyni*, De Koninck, but it is very much smaller and possesses only half the number of septa. There is no trace of a septal fossula at all, and in all probability the epitheca was very thin. There are about thirty septa, and the costæ are regular and very apparent, whilst the central tabular space is large for the size of the corallum. Although the specimen is only a fragment, the corallum was evidently cylindrical and somewhat curved.

*Loc.* Broken River, a tributary of the Clarke River. (*R. L. Jack.*)

Genus—*CAMPOPHYLLUM*, Edwards and Haime, 1850.

(Mon. Brit. Foss. Corals, Pt. 1, p. lxxviii.)

*CAMPOPHYLLUM GREGORII*, *sp. nov.*, Pl. 3, figs. 15-18.

*Sp. Char.* Corallum long, either straight or gently curved, and sometimes slightly twisted. Epitheca apparently thin, and with indistinct growth accretions. Septa numerous, sixty at least, gradually tapering at the extremities; secondary septa less than half the length of the primary, and much more slender. Vesicular tissue forming a zone having a width about equal to the length of the secondary septa, the vesicles small and close together. Septal fossula large, containing one primary septum (or sometimes two?) Central tabulate area conspicuous, almost equal in breadth to the length of the primary septa. Tabulæ horizontal, or sometimes slightly oblique and very close to one another, in places almost touching.

*Obs.* The genus *Campophyllum* has not been extensively recognised as Devonian, but investigation will probably prove it to have flourished at that period to a greater extent than has been supposed. Prof. L. G. De Koninck has recorded the occurrence of *Campophyllum flexuosum*, Ed. and H., in the Lower Devonian Series of Quadong, N. S. Wales, but I believe this is the only species yet recognised in Australia. The present coral is quite distinct from the latter, and I feel much pleasure in associating with it the name of the Hon. A. C. Gregory, who has for so many years been connected with Australian science and exploration.

*Loc.* Regan's, Benwell's, and Philp's, Northern Railway. (*R. L. Jack.*)

## Order—ALCYONARIA.

## Family—HELIOLITIDÆ.

Genus—*HELIOLITES*, Dana, 1846.

(Zoophytes, Wilkes U. S. Expl. Exped., p. 541.)

*Obs.* The Silurian and Devonian rocks of one or other of the Australian Colonies have yielded six species of this genus, so far as present researches have gone, and to these we have to add a seventh and eighth.

*Heliolites interstinctus*, Linn., has been met with, according to Prof. McCoy,\* in the Upper Silurian Limestone of Waratah Bay, Victoria. The researches of Prof. De Koninck have shown the existence of *H. megastoma*, McCoy, and *H. Murchisoni*, in

\* As *Palæopora*, in Progress Report for 1876, No. iv., Geol. Survey Vict., by T. Couchman, pp. 156, 158 (Melbourne, 8vo., 1877).

the Upper Silurian rocks (probably Ludlow or Wenlock) of New South Wales, at Burrowang,\* whilst the supposed Devonian of the same colony has yielded *H. porosa*, Goldf.† The same species has been shown by Prof. Nicholson and the Writer to occur plentifully in the Devonian Limestones of North Queensland, accompanied by three other and interesting forms—viz., *Heliolites Daintreei*, *H. plasmoporoides*, and an indicated species which is now named *Heliolites Nicholsoni*. The most aberrant species of the genus is *H. plasmoporoides*, Eth. fil. and Nich., which nearly approaches the genus *Plasmopora*, by its comparatively irregular and few interstitial tubes.

*HELIOLITES POROSA*, Goldfuss, Pl. 1, fig. 6.

*Astræa porosa*, Goldfuss, Petrefacta Germaniæ, 1826, i., p. 61, t. 21, f. 7.

*Heliolites porosa*, M.-Edwards and Haime, Polyp. Foss. Terr. Pal., 1851, p. 218.

" " M.-Edwards and Haime, Mon. Brit. Foss. Corals, 1853, Pt. 4, p. 212, t. 47, f. 1 a-f.

" " De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1876, Pts. 1, 2, p. 81.

" " Nicholson and Eth. fil., Ann. and Mag. Nat. Hist., 1879, iv., p. 223.

*Obs.* Under this name we have assembled from localities in North Queensland a series of specimens varying more or less slightly in their characters amongst themselves, but which we think are all referable to *Heliolites porosa*, Goldf. The composite corallum in these corals is massive, with a flat under surface or base, having few and faintly marked concentric ridges. The calices in all the specimens are circular, pretty equally developed in the same individual, and separated by unequal interspaces occupied by cœnenchymal tubes‡; each calice varies from  $\frac{1}{2}$  to  $\frac{3}{4}$  line in diameter. The tubes of the cœnenchyma are rather small and polygonal, and constitute somewhat large interspaces between the corallites. The septa are only visible here and there.

Upon comparing a series of specimens of *H. porosa* from German and British Devonian rocks, we find that considerable variation takes place—1st, in the diameter of the corallites themselves; 2nd, in the size of the cœnenchymal tubuli; 3rd, in the amount of intercalicular space occupied by the latter; and 4th, in the length of the septa. These variations are, indeed, shown in the figures given by MM. Milne-Edwards and J. Haime. So far as we are able to judge, the Queensland examples appear to occupy a median place in the above scale; the diameter of the corallites and cœnenchymal tubuli is greater than in some European examples and less than in others. On the whole the interspaces occupied by the tubuli are perhaps greater in the Queensland examples.

In vertical sections we can distinguish with ease the tabulæ, as described by Edwards and Haime, horizontal, but sometimes oblique. These authors describe the cœnenchymal tubuli as "nearly regularly hexagonal." Certainly this is the case with some of the tubes on various parts of the Queensland specimens; but we find by far the commoner form is the polygonal.

*Loc.* Broken River, a tributary of the Clarke River (*The late R. Daintree*); Fanning River, Burdekin Downs; Arthur's Creek, Burdekin Downs (*R. L. Jack*).

*HELIOLITES DAINTREEI*, Etheridge fil. and Nicholson, Pl. 1, figs. 7, 8.

*Heliolites Daintreei*, Nicholson and Eth. fil., Ann. and Mag. Nat. Hist., 1879, iv., p. 224, t. 14, f. 3 a, b.

*Sp. Char.* Corallum compound, discoid or flattened; upper surface a little convex; under surface more or less flattened, concentrically wrinkled round the edges.

\* Foss. Pal. Nouv.-Galles du Sud, 1876, Pt. i., pp. 24, 25.

† *Ibid.* p. 81.

‡ In this and in the following descriptions of species of *Heliolites* the terms "cœnenchyma" and "cœnenchymal tubes" are used simply in accordance with previous custom, and for the sake of convenience. There is, of course, no true "cœnenchyma" in *Heliolites* and its allies, and the so-called "cœnenchymal tubes" are really a specialised series of small corallites.

Calices large, equal in size, with a diameter of  $\frac{3}{4}$ -line, or at times almost 1 line, closely set; calicular edge deeply scalloped. Septa numerous and well marked, certainly fourteen and sometimes more, unequal in size. Cœnenchyma composed of large and well-developed tubes separating the corallites by irregular interspaces, often of small extent. A specimen measures  $3\frac{1}{2}$  by nearly 4 inches. (*Nicholson and Etheridge fil.*)

*Obs.* *H. Daintreei* may be distinguished by the size and contiguity of the large corallites, with their strongly scalloped margins. The cœnenchymal tubuli are irregularly developed, for between neighbouring calices we occasionally see only one row of tubes, but more commonly the number is increased to two. The latter number varies up to three or four, beyond which we have not observed them to be increased.

In the contiguity of its calices and frequent diminution of the tubuli, *H. Daintreei* resembles *H. megastoma*, McCoy, of the British Silurian rocks, but is at once distinguished by the prominent scalloped edges of the calices, and the flat or little-convex form of the corallum.

In the contiguity of the corallites one to the other there is a good deal of resemblance between *H. Daintreei* and *H. pyriformis*, Lonsdale, as figured by Hall from American specimens, but the other characters are quite dissimilar. (*Nicholson and Etheridge fil.*)

*Loc.* Broken River, a tributary of the Clarko River. (*The late R. Daintree.*)

HELIOLITES PLASMOPOROIDES, *Etheridge fil. and Nicholson*, Pl. 1, figs. 9-11.

*Heliolites plasmoporoides*, Nicholson and Eth. fil., Ann. and Mag. Nat. Hist., 1879, iv., p. 25, t. 14, f. 2 a, b.

„ „ Nicholson, Tabulate Corals Pal. Period, 1879, p. 245.

*Sp. Char.* Corallum irregularly ovate; upper surface convex. Calices circular, with a thin thread-like margin, average diameter  $1\frac{1}{2}$  line, contiguous, but separated from one another by small interspaces of cœnenchymal tubuli. The latter are large and of very irregular form; some are elongate with one axis much longer than the other, others are polygonal; and, again, others are without definite outline. Between contiguous corallites there is usually but one row of large oblong interstitial tubes, reaching from calice to calice; or, where the corallites become a little separated from one another, these may be increased in number. Septa almost obsolete, thread-like. A specimen measures 5 inches by 4. (*Nicholson and Etheridge fil.*)

*Obs.* The form and arrangement of the cœnenchymal tubuli render the present species a very interesting one. If horizontal sections in the mass are examined only with the naked eye or ordinary lens, the species will be pronounced a *Plasmopora*; and this it at first appeared to us to be. It has all the general appearance of this genus, especially in the fact that there is often but a single row of oblong interstitial tubes between every two corallites. In such sections the walls of these tubes have quite the appearance of thread-like costæ radiating from corallite to corallite, or bifurcating at various angles where their number is increased between the corallites, as in *Plasmopora*. When, however, vertical microscopic sections are examined, the true affinities of this peculiar coral at once become apparent. In the first place, the arched and vesicular tabulæ of *Plasmopora* are wanting, and we find in their place the straight horizontal diaphragms of *Heliolites*. Secondly, in similar sections the interstitial or cœnenchymal structure is found not to consist of vertical canaliculi formed by the irregularly developed walls of the tubuli, and subdivided by horizontal or convex dissepiments into irregularly formed cells as in *Plasmopora*, but of a series of small, regular, and well-developed cells formed by the intersection of the vertical tubuli and their horizontal tabulæ, which are usually placed on the same level and correspond with one another, precisely as seen in vertical sections of *Heliolites megastoma*, McCoy.

So far as our investigations enable us to form an opinion, *H. plasmoporoides* is most nearly allied to *H. megastoma*, McCoy; indeed, in the figure of this species given by Edwards and Haime we notice the one-celled disposition of cœnenchyma in places similar to that seen in the present species. The latter, however, is clearly distinguished from *H. megastoma*. (*Nicholson and Etheridge fil.*)

*Loc.* Broken River, a tributary of the Clarke River. (*The late R. Daintree.*)

#### HELIOBITES NICHOLSONI, *sp. nov.*, Pl. 1, fig. 12.

*Helioites, sp. ind.*, Nicholson and Eth. fil., Ann. and Mag. Nat. Hist., 1874, iv., p. 225.

*Sp. Char.* Corallum in the form of rounded or sub-lobate masses of small dimensions. Corallites circular, separated from one another by intervals of cœnenchyma varying from 2 to 2½ millimetres in diameter. Calices very small, about ¼-mm. across, with very thin and thread-like margins; septa delicate and short; tabulæ moderately close and nearly horizontal. Cœnenchymal tubuli exceedingly delicate and small, almost microscopic, hexagonal or polygonal; tabulæ quite horizontal and moderately close.

*Obs.* A third and small species of *Helioites* is represented by several examples nestling in the middle of a large block of *Favosites*. The calices and cœnenchymal tubuli are very small, the latter so much so that the use of a lens is required for their detection.

In a vertical section the structure is characteristically heliolitiform. In the interspaces between the corallites, the small square cells making up the cœnenchyma are quite apparent, but rather unequal in size. The tabulæ in the corallites are moderately close and horizontal.

Traces of very small septa remaining in one or two of the corallites have been observed, but their structure is so delicate and minute that their preservation is surprising. It is very probable that this is an undescribed minute *Helioites*, for which the name of *H. Nicholsoni* is proposed. It appears to be smaller in general than any of the commoner species of *Helioites*, especially as regards the size of the cœnenchymal tubes.

*Loc.* Broken River, a tributary of the Clarke River. (*The late R. Daintree.*)

#### Family—AULOPORIDÆ.

##### *Genus—AULOPORA, Goldfuss, 1826.*

(*Petrefacta Germaniæ*, i., I Theil, p. 82.)

##### AULOPORA REPENS (*Knorr and Walch.*), *Edwards and Haime.*

*Aulopora serpens*, Goldfuss, *Petrefacta Germaniæ*, 1826, I Theil, p. 82, t. 29, f. 1.

„ *repens*, Edwards and Haime, *Polyp. Foss. Terr. Pal.*, 1851, p. 312.

„ „ Nicholson and Eth. fil., Ann. and Mag. Nat. Hist., 1879, iv., p. 282.

„ „ Hinde, *Geol. Mag.*, 1890, vii. (3), p. 199, t. 8, f. 6.

*Obs.* We have an example of this interesting coral creeping over the surface of a specimen of *Helioites porosa*. The weathering of the surface of the coral has removed the epitheca and exposed wall of the *Aulopora*, and laid bare the interiors of the ramifying or stolon-like corallites. (*Nicholson and Etheridge fil.*)

The spaces enclosed by the union of the corallites are irregular in shape, some polygonal, others elongated. The corallites either occur along the course of the creeping network, or are thrown off as a small projection at each bifurcation. There is no regularity in their disposition; at one point they succeed one another very rapidly along the creeping tubes, and are much crowded; but on other portions they are scattered and separated by much greater interspaces. On the edge of the corallum,

where the reticulation becomes of a more open nature, the zigzag appearance given to the corallites by frequent dichotomization becomes very apparent. There are no septa visible in this example. (*Nicholson and Etheridge fil.*)

*Loc.* Arthur's Creek, Burdekin Downs. (*R. L. Jack.*)

#### AULOPORA, *sp. ind.*

*Obs.* The habit of growth of a second species from a different locality resembles the Eifelian coral *Aulopora spicata*, Goldfuss.\* Its general aspect is that of the genus *Vermipora*, Hall, a likeness which is strengthened by the fact that Prof. H. A. Nicholson† has suggested the reference of *A. spicata* to this genus. One specimen appears to possess mural pores, a character which, if present, would assist in setting the question at rest.

Another specimen from the same locality ramifies around a rugose coral, and is surrounded by a Stromatoporoid. Microscopic sections of this specimen display nothing more than the ordinary auloporoid structure. It possesses the habit of *Syringopora auloporoides*, De Kon.,‡ but is much smaller, and appears to be a true *Aulopora*.

*Loc.* Regan's and Philp's, Northern Railway. (*R. L. Jack.*)

### Sub-Kingdom—ECHINODERMATA.

#### Section—PELMATOZOA.

#### Class—CRINOIDEA.

#### Order—PALÆOCRINOIDEA.

Of the Palæocrinoidea from Queensland localities, none have yet been brought under my notice. I can only record that Mr. Jack reports that Encrinites are of common occurrence in shales interstratified with the limestone beds of the Broken River. Mr. Jack informs me that the Encrinites were unmistakable; but as he was aware that their state of preservation would not permit of specific determination, he did not, considering the difficulties of transit, bring away any specimens.

### Sub-Kingdom—MOLLUSCA.

#### Class—BRACHIOPODA.

#### Order—TRETENTERATA.

#### Family—SPIRIFERIDÆ.

*Genus—SPIRIFERA*, J. Sowerby, 1816.

(*Min. Con.*, ii., p. 41.)

*SPIRIFERA CURVATA*, Schlotheim, Pl. 37, figs. 3-5, 7.

*Anomia Terebratulithes curvatus*, Schl., Nachträge zur Petrefact., 1882, p. 68, t. 19, f. 2.

*Spirifera curvata*, Davidson, Mon. Brit. Dev. Brach., 1864, Pt. 1, p. 39, t. 4, f. 29-32; t. 9, f. 22, 26, 26a, 27, 27a-c (for synonymy).

„ „ Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 269.

*Obs.* A full description of this species by the late Dr. T. Davidson will be found in his work quoted in the synonymy.

\* Petrefacta Germaniæ, 1826, I. Theil, t. 29, f. 3.

† Tabulate Corals Pal. Period, 1879, p. 112.

‡ Foss. Pal. Nouv.-Galles du Sud., 1876, Pts. 1, 2, p. 76, t. 3, f. 1.

In the Queensland examples the sulcus of the ventral valve channels the umbo high up, and gradually broadens out towards the front, which is well sinuated. The fold of the dorsal valve is not high, but narrow and ribless, except at the front sinuated margin, where it rather projects upward. The hinge line is less than the width of the valves, the area of the ventral valve being short and low, whilst the alar angles are rounded. Both beaks are fairly prominent, and that of the ventral valve incurved. The surface always appears quite smooth.

The narrow sinus and fold and the channelling of the ventral umbo just referred to are well shown in Dr. Davidson's figures of European specimens, and serve to strengthen the identity of the respective fossils.

The crushed condition of the specimens on which the present identification was originally made, left room for some doubt. Additional examples, however, quite confirm the presence of *S. curvata* in the Queensland Devonian fauna. These, as above stated, are smooth, but this results simply from the state of preservation, for it must not be forgotten that on the original example there were traces of the characteristic concentric imbrications, with the peculiar vertical serrations crossing them.

In general habit *S. curvata* resembles some small examples of the Carboniferous *Martinia glabra*; and again *S. levis*, Hall,\* of the Portage Group (Upper Devonian) of North America.

*Loc.* Fanning River, and Fanning Old Station, Burdekin Downs. (*R. L. Jack.*)

#### SPIRIFERA EURYGLOSSA, Schnur, Pl. 4, fig. 1.

*Spirifer euryglossus*, Schnur, Palaeontographica, iii., p. 209, t. 36, f. 5 a-d.

*Spirifera euryglossa*, Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 269, t. 7, f. 1.

*Obs.* Another *Spirifer* occurs in the Fanning Limestone, of which we at present have only one specimen. It is quite decorticated, much smaller than the preceding, with a deep well-pronounced sulcus in the ventral valve extending well up on the beak, and bounded by strong ridge-like margins. In the dorsal valve there is a corresponding medial fold although not relatively so prominent as the sulcus. The hinge line was less in length than the width of the shell. It appears to resemble some of the *Martinia glabra* group, but the loss of the shelly matter renders identification difficult, especially as we have only one specimen. A close resemblance exists between *Spirifera euryglossa*, Schnur, and the present species.

*Loc.* Fanning River, Burdekin Downs. (*R. L. Jack.*)

#### Family—ATRYPIDÆ.

*Genus*—*ATRYPA*, Dalman., 1828.

(Könl. Vet. Acad. Handl. för år. 1827, p. 102.)

*ATRYPA RETICULARIS*, Linnæus, Pl. 4, fig. 4.

*Anomia reticularis*, Linn., Syst. Nat., 1776, 12th Ed., i., Pt. 2, p. 1152.

*Atrypa reticularis*, Davidson, Mon. Brit. Dev. Brachiopoda, 1864, Pt. 1, p. 53, t. 10, f. 3, 4 (*for synonymy*).

" " Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 270, t. 7, f. 2.

" " Foord, Geol. Mag., 1890, vii. (3), p. 100, t. 5, f. 1, and woodcut, f. a, b.

*Obs.* Numerous specimens of this world-wide species have now been collected in North Queensland, supporting the original determination made by the Writer. There

\* Pal. N. York, 1867, iv., Pt. 1, t. 39, f. 1-12.

can be little doubt that *A. reticularis* is a very characteristic shell of the Fanning Limestone. The larger number of the specimens are a good deal weathered, but in the original example "the characteristic decussating frills or laminae are preserved on both valves, but they are seen to much greater advantage on the ventral valve." One of the recently collected specimens, apparently of this species, shows traces of the spines around the broken edges of the shell.

The only apparent real difference between this species and the next, is the presence of the area in the latter. This however, varies much, both in length and height, and at times is even very difficult to distinguish. Indeed, from an examination of these specimens I can quite understand the late Dr. Davidson's difficulty, expressed in the following words—"I am very uncertain whether *Atrypa desquamata* be really more than a variety of *A. reticularis*."

*Loc.* Fanning River, Burdekin Downs, and Fanning Old Station. (*R. L. Jack.*)

*ATRYPA DESQUAMATA*, *J. de C. Sowerby*. Pl. 4, figs. 2, 3; Pl. 37, fig. 8.

*Atrypa desquamata*, *J. de C. Sby.*, Trans. Geol. Soc., 1840, 31 Ser., v., Expl. of t. 56, t. 56, f. 19, 20.

" " Davidson, Mon. Brit. Dev. Earth., 1864, Pl. 1, p. 58, t. 10, f. 9-13, t. 11, f. 1-9 (*for synonymy*).

" " Etheridge & L., Proc. R. Phys. Soc. Edinb., 1880, v., p. 270, t. 7, f. 3, 4.

*Obs.* From the series of figures of *Atrypa desquamata* given by Dr. Davidson, it is quite clear that the species is one of considerable variation, both in the relative dimensions of the shell, from the hinge line or beak to the front margin, and also laterally, from side to side, the result being that the length of the hinge line is also variable, short in some varieties, longer in others.

We possess several shells from the Fanning River Beds which are more than probably this species. If we take the best preserved of these, we find that it is very much more transverse than those represented by Dr. Davidson on Pl. x. of his Devonian Monograph, but not more so than some of the figures of Pl. xi. of the same work. Again, the relative convexity of the valves when in apposition is very much less than Dr. Davidson's fig. 13 of Pl. xi., but is a little more pronounced than the fig. 3a of the same plate. Even among the three Queensland examples the shape varies somewhat. The ribbing of the valves corresponds with that seen in *A. desquamata*, and there are also traces of concentric laminae. The above Author laid stress on the exposure of the foramina, aperture and presence of an area. Both are to a certain extent visible in one of the earlier specimens collected. In one of the more recently acquired examples the beak of the ventral valve is very acute and prominent. The strength of the surface costae or ribs is not in every case equal, some being much more prominent and pronounced than others. The ventral valves are gently but regularly curved, and there is a moderately pronounced sinuation in the front margin.

Professor McCoy appears to have been the first to describe\* the spiral appendages in *A. desquamata*, and they have since been figured in their entirety by Dr. Davidson†. It is interesting to note that two of the specimens under description exhibit traces of these appendages from the shell having been removed by weathering.

*Loc. and Horizon.* Limestone of the Fanning River, and shale above the Fanning Limestone, at Fanning Old Station, Burdekin Downs. (*R. L. Jack.*)

\* Brit. Pal. Foss., 1857, Fac. 2, p. 829.

† Loc. cit., t. 11, f. 7, 8.



## Family—RHYNCHONELLIDÆ.

Genus—*RHYNCHONELLA*, Fischer, 1809.

(Notice Foss. Gouv. Moscou, p. 35.)

*RHYNCHONELLA PRIMIPILARIS*, Von Buch, Pl. 4, fig. 5.*Terebratula primipilaris*, Von Buch, Phys. Abhandl. K. Akad. Wissensch. Berlin, 1835, p. 88, t. 2, f. 29 a-c*Rhynchonella primipilaris*, Davidson, Mon. Brit. Dev. Brach., 1865, Pt. 2, p. 66, t. 14, f. 4-6.,, *sp. ind.*, Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 271, t. 7, f. 5.

*Obs.* Several *Rhynchonellæ* from the Fanning horizon have given much trouble from the state of their preservation, which is unsatisfactory, but they appear to correspond better with the characters assigned by Dr. Davidson to Von Buch's species than to any other. The shape of the shell appears to be much the same, and the bending down of the front margin of the dorsal valve is quite apparent in all the specimens. On submitting the specimens to Dr. Davidson he replied that "the *Rhynchonellæ* seem to be very close to the *R. primipilaris* of the Devonian."

*Loc. and Horizon.* Fanning Old Station, Burdekin Downs, in shale above the Fanning Limestone. (*R. L. Jack.*)

Genus—*PENTAMERUS*, J. Sowerby, 18—.

(Min. Con. i., p. 73.)

*PENTAMERUS BREVIROSTRIS*, Phillips, Pl. 37, figs. 6, 9-11.*Stringocephalus brevirostris*, Phillips, Pal. Foss. Cornwall and Devon, 1841, p. 80, t. 32, f. 143.*Pentamerus brevirostris*, Davidson, Mon. Brit. Dev. Brach., 1865, Pt. 2, p. 72, t. 15, f. 1-14.

*Obs.* This is an exceedingly variable species, sub-orbicular, circular, or broad-ovate; the dorsal valve with or without a mesial fold, and sometimes even with a sinus; and the ventral valve evenly gibbous, or with a slight fold, and ornamented or not with a few slight longitudinal ribs.

Amongst the Queensland examples is a specimen in which both valves possess a mesial fold, and the front margin is a good deal sinuated; whilst in others the ventral valve is quite plain; another in which the fold is faintly ribbed; and again others in which the dorsal valve is itself without a fold. As regards form, we are presented with the long sub-orbicular outline, the broad-ovate condition, and one individual in which the shape is almost circular. Indeed, the various outlines accord so well with those of European specimens as to be remarkable, the only difference traceable being the less development of the area in the Australian examples, and the consequent concealment of the fissure; this is, however, perhaps assisted by the greatly incurved ventral umbones. A fractured example of the ventral valve shows the septum, so characteristic of the genus, which is large and well developed. The shelly plates of the same valve had no great degree of divergence.

*Loc. and Horizon.* Fanning Old Station, Burdekin Downs; Fanning Limestone. (*R. L. Jack.*)

## Family—STRINGOCEPHALIDÆ.

Genus—*STRINGOCEPHALUS*, DeFrance, 1827.\*

(Dict. Sci. Nat., 1827, p. 102.)

*STRINGOCEPHALUS* ? *sp. ind.*

*Obs.* A single very imperfect specimen has been obtained from the Fanning Limestone, which I believe to be referable to this genus. It consists of a maltreated

\* Emend. Sandberger, Neues Jahrb., 1842.

ventral valve of a large Brachiopod, with indications of a long septum, a moderately wide but not high area, and a particularly lofty umbonal region. Notwithstanding its imperfect state it even now measures 3 inches square.

I am not acquainted with any other Devonian shell of sufficient size to be confounded with this, and have, therefore, provisionally referred it to *Stringocephalus*.

*Loc. and Horizon.* Fanning Old Station, Burdekin Downs; Fanning Limestone. (*R. L. Jack.*)

### Family—STROPHOMENIDÆ.

*Genus*—*ORTHOTETES*, *Fischer*, 1829.

(*Bull. Soc. Imp. Nat. Moscou*, 1829, p. 375.)

*ORTHOTETES UMBRACULUM*, *Schlotheim*.

*Terebratulites umbratulum*, Schl., *Petrefactenkunde*, 1820, p. 256.

*Streptorhynchus umbraculum*, Davidson, *Mon. Brit. Dev. Brach.*, 1865, Pt. 2, p. 76, t. 16, f. 6; t. 18, f. 1-5.

*Spirifera crenistria*, Phillips, *Geol. Yorkshire*, 1836, ii., p. 216, t. 9, f. 6.

*Streptorhynchus crenistria*, Davidson, *loc. cit.*, 1865, Pt. 2, p. 81, t. 18, f. 4-7.

*Orthotetes crenistria*, De Koninck, *Foss. Pal. Nouv.-Galles du Sud*, 1877, Pt. 3, p. 212, t. 10, f. 8.

„ „ Etheridge fil., *Proc. R. Phys. Soc. Edinb.*, 1880, v., p. 272.

*Obs.* The late Dr. Davidson called attention to the questionable separation of *Orthotetes umbraculum*, Schl., sp., and *O. crenistria*, Phill., sp., and explained how the two species had been confused by Authors. It appears from his own showing to be a multiplication of names, as no good line of demarcation exists between the so-called species.

In the Queensland Devonian examples the ventral valve is convex, the interspaces between the coarser ribs being occupied by from three to four finer ones. The dorsal valve is flat, or a little concave. One of the specimens in its present state is quite 3 inches wide by 2 inches high, but when perfect was wider. On the other hand no great depth existed between the valves. Like typical forms of *O. umbraculum*, the present shells possessed a well-developed area.

*Loc.* Fanning Old Station, Burdekin Downs. (*R. L. Jack.*)

*ORTHOTETES ? CONCENTRICA*, *sp. nov.*, Pl. 37, figs. 13, 14.

*Sp. Char.* Transversely semicircular, compressed, slightly curved, thin towards the front. Ventral valve flatly convex above, becoming concave towards the front; umbo projecting outwards almost at right angles to the hinge line, and very sharp. Dorsal valve slightly rounded in the umbonal region, and following the contour of the ventral valve. Area large and triangular, almost flat. Surface of the ventral valve with faint radiating lines, crossed by markedly concentric imbricating laminae, giving rise to a dull reticulation. Dorsal valve ornamented in a similar manner, but the concentric laminae predominating.

*Obs.* This is a peculiar and interesting little form, especially in the ornamentation of the surface, which is not of a character usual in this genus. In outline it seems to approach *Streptorhynchus pectiniformis*, Dav.,\* of the Salt Range Group, India, more than any other species.

*Loc.* Fanning Old Station, Burdekin Downs. (*R. L. Jack.*)

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\* Waagen, *Pal. Indica*, Ser. xiii., Vol. i., No. 4, Pt. 3, t. 55, f. 4-11.

## Class—CEPHALOPODA.

## Order—TETRABRANCHIATA.

## Family—NAUTILIDÆ.

Genus—GYROCERAS, *De Koninck*, 1844.*Gyroceras*, De Kon., Anim. Foss. Terr. Carb. Belg., 1844, p. 530.

,, Blake, Mon. Brit. Foss. Cephalopoda, 1882, Pt. i., p. 65.

*Obs.* *Gyroceras* is here used in the restricted sense as defined by Prof. J. F. Blake.

GYROCERAS PHILPI, *sp. nov.*, Pl. 4, figs. 6, 7.

*Sp. Char.* Shell large, of one and a-half to two whorls, somewhat irregularly convoluted; section of the whorls apparently scutiform, and depressed or flattened on the ventral side; diameter of the shell as preserved,  $5\frac{1}{2}$  inches; chambers shallow for size of the shell; septa, of which there are about fifty visible, appear to be excavated towards the rear on the back and ventral side, and to be arched forward on the flanks—at the younger end of the shell the septa average  $\frac{1}{8}$ -inch apart, but in the older portions they are much closer; siphuncle moderately large, and dorsal in position; the back was traversed in the direction of its growth by a number of sharp, parallel, semituberculate, spiral ridges; the younger portion of the shell, at least, appears to have been ornamented by distant obtuse nodes on the sides overhanging the open umbilicus, whilst both the nodes and the interspace between them carry very fine epithecal striæ, which describe the same curve as the septa.

*Obs.* This genus has not hitherto been recognised in the Devonian rocks of Australia. The specimen from which the above description is drawn up is unfortunately not entirely preserved, nearly one-half of the shell having been removed longitudinally by weathering. The body chamber is only partially preserved, to the extent of  $1\frac{1}{2}$  inches. *G. Philpi* bears some resemblance to *G. ornatum*, Goldfuss, as figured by G. and F. Sandberger,\* whose figure shows the same indistinct nodes on the sides, and the same spiral ridges on the back, but *G. ornatum* appears to have been a much more robust species than ours. It again resembles *G. nodosum*, Goldfuss, as figured by Bronn,† in the possession of the distant nodes at the sides, but does not appear to correspond with the latter in the section of its shell. The species is named in honour of the discoverer, Mr. John Philp, senr., of Townsville.

*Loc.* Philp's, Northern Railway (*R. L. Jack*); Reid Gap, near Townsville (*G. Sweet*—Golln. Sweet, Melbourne); Fanning River, near Fanning Old Station (*R. L. Jack*).

E.

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\* Versteinerungen Schichtens. Nassau, Atlas, t. 13, f. 1, 1 a, b.

† Lethæa Geog., Dritte Auflage Atlas, t. 1, f. 4.

## CHAPTER VI.

### THE PERMO-CARBONIFEROUS SYSTEM.

THE greater part of the stratified rocks of the eastern ranges of Queensland may be grouped together in a system to which the name of Permo-Carboniferous may appropriately be applied. This system includes at least four, and possibly five, distinct formations, namely—the Gympie, Star, and Lower, Middle, and Upper Divisions of the Bowen River Coal Field.

The two first yield a flora in no way allied to that which is found in the three succeeding divisions but possessing a decidedly Carboniferous *facies*, the distinguishing plant being *Lepidodendron*. The plant beds are associated with a marine fauna, which, indeed, preponderates largely over the flora in the Gympie Formation.

There is not, indeed, much to indicate whether the Gympie Formation is older than the Star, or *vice versâ*. Certainly no section has come to light revealing their relation to one another. But from the fact that the strata of the Gympie Formation (except in a limited area of the type district) are almost always highly inclined and to some extent metamorphosed, while the Star Formation is generally little disturbed and little altered, it may be surmised that the latter is unconformably related to the former; and for the present it is desirable to keep the two formations distinct, although the accumulation of palæontological evidence appears to be tending to bridge over the gap between them.

#### J.

The three Bowen River Formations are distinguished both by the presence of a copious marine fauna, partaking of a Carboniferous and Permian nature, and a flora from which Lycopodiaceous plants are almost entirely absent, being replaced by others of a less Palæozoic and more Mesozoic description. In the Middle Formation of the Bowen River Coal Field we find a preponderating Palæozoic fauna, and the much-debated fern *Glossopteris* scantily represented. On the other hand, in the Upper Formation of the Bowen River Coal Field this fern assumes a prominent position, and the older fauna is either absent or reduced to a minimum. The Lower and Middle Bowen Formations and their representatives in New South Wales have usually been termed "Carboniferous." They do not, however, wholly correspond to that formation as developed in Europe, but rather homotaxially represent both it and the overlying Permian Formation. Hence, referring to the Queensland beds only, I some years ago\* proposed to call this series of beds Permo-Carboniferous. I still believe this to be the nearest comparison which can be made, and am desirous of extending it to the whole of these deposits throughout Eastern Australia.

The notably Carboniferous *facies* of the Lower and Upper Marine fauna of New South Wales, and the Bowen, Gympie, and Rockhampton corresponding series, hardly requires demonstration, whilst a resemblance to the Permian is brought out greatly by such forms as *Strophalosia*, *Stenopora*, and large Polyzoa of the *Protoretzpora* type, and

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\* Proc. R. Phys. Soc. Edinb., 1880, v., p. 319.

by the strong resemblance of the typical forms of *Productus* to the characteristic *P. horridus* of the Magnesian Limestone and Zechstein. This subject was fully discussed in my account of "A Collection of Fossils from the Bowen River Coal Field," &c.,\* wherein I concluded as follows:—"The examination of these Bowen River fossils, so far as it has gone, leads me to regard them as occupying a high position in the Palæozoic Series; and that all purposes would best be served by regarding them as of Permo-Carboniferous age." This view has gained strength, the more the facts have been investigated, and I am now anxious to extend the adoption of this term to the whole of the similar formations in New South Wales.

One of the most important points of difference between the Carboniferous Series of Europe and the coal-bearing rocks of Eastern Australia lies in the almost entire absence of Lycopodiaceous plants from the latter, above a certain horizon very low in the series. The place of this division of the Vegetable Kingdom is taken by the fern *Glossopteris*, and the continuity of the whole strata, now proposed to be termed Permo-Carboniferous, both in New South Wales and Queensland, is shown by the passage of this genus from the Middle to the Upper Bowen Formation and its persistence therein.†

The strata of the Oakey Creek Coal Field, Cooktown, contain *Glossopteris*, and are regarded by Mr. Jack as the equivalent of the Upper or Freshwater division of the Bowen Series. The Little River Coal Field beds near Palmerville, and those of Stewart's Creek near Townsville, are in the same category. It will be noticed that throughout the horizons regarded as the equivalents of the Upper Bowen Formation there is an entire absence of the genera *Taniopteris* and *Thinnfeldia*, both of which become eminently characteristic of the Mesozoic Coal Measures described later on. It seems more than probable that the occurrence of these genera will afford a reliable basis, not only in Queensland, but equally so in New South Wales, for the separation of those strata which I am desirous of terming Permo-Carboniferous, from the still higher series, a portion of which, at least, are clearly of Jurassic age.

With the elaborate classification, extending from the Trias to the Jurassic, proposed by the Revd. J. E. Tenison Woods,‡ or the still more beautifully fitting stratigraphical tabulation devised by Prof. O. Feistmantel,§ I cannot at the present moment coincide. No fossil organic remains are so deceptive or unsuitable for determining questions of equivalent stratigraphy, as plants, and we know too little, not only of the boundaries of formations in this quarter of the globe, but also of their organic contents, to warrant speculations of this kind. That we have beds of Triassic age, and others again representing some portion of the Jurassic, is probably the case, but it is impossible to enter into minute stratigraphical subdivisions yet, on the mere chance of statements ultimately proving correct..

E.

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\* Proc. R. Phys. Soc. Edinb., 1880, v., p. 319.

† *Glossopteris* is not as yet known in any of the Queensland Mesozoic formations except, strange to say, in the very uppermost division of the Desert Sandstone.

‡ Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. i., pp. 53, 54.

§ Palæontographica, 1878-79, Sup. Bd. iii.

## CHAPTER VII.

### THE PERMO-CARBONIFEROUS SYSTEM—*continued*.

#### THE GYMPIE FORMATION IN THE TYPE DISTRICT.

**Mineral Areas—viz., Gympie Gold Field and Weerdie Antimony Mine.**

To a series of strata which attain an immense development in the south-eastern portion of the Colony, and are probably represented in many portions of the eastern coast district to the North, we have given the name of the "Gympie Beds," from the gold-field where they have, for the most part, been studied. To this series, so far as yet known, we have neither recognised a base nor a top. Its place in the geological scale must therefore, for the present, be determined mainly on palæontological evidence.

The late Mr. D'Oyly H. Aplin, Government Geologist for South Queensland, made a report to the Government "On the Geological and Mining Features of the Gympie Gold Field"\* in 1868.

Mr. T. B. Hacket, Mining Surveyor, published in 1870 a Geological Map of the Gympie Gold Field, but was content to distinguish "Greenstone," "Fossiliferous Greenstone and Slate," and "Slate and Sandstone."

Mr. Daintree, in his paper on the "Geology of Queensland,"† made some references to the "Devonian" rocks of the Gympie Mining District, from which he made a collection of fossils which were determined by Mr. R. Etheridge, F.R.S. Mr. Etheridge's list of fossils hardly bears out the reference of the strata to the Devonian. Of the fourteen fossils specifically determined by him, six (viz., *Ceriodora* (?) *laxa*, Eth., *Spirifera dubia*, Eth., *Aviculopecten imbricatus*, Eth., *A. multiradiatus*, Eth., *Edmondia concentrica*, Eth., and *E. obovata*, Eth.) are species either new or doubtful; four (viz., *Productus cora*, D'Orb., *Spirifera bisulcata*, Sby., *Aviculopecten limæformis*, Mor., and *Pluritomaria carinata*, Sby.) are European Carboniferous. One of the new species (viz., *Ceriodora laxa*) is most nearly allied to an Irish Carboniferous species. Another (*Strophomena rhomboidalis*, var. *analoga*, Phill.) ranges in Europe from Silurian to Carboniferous; while only one (viz., *Spirifera undifera*, var. *undulata*, Römer.) is exclusively Devonian. The balance of evidence, therefore, so far as it was before Mr. R. Etheridge, F.R.S., appears to have been in reality much in favour of a homotaxial relation with the European Carboniferous.

Mr. A. C. Gregory, in his "Report on the Geology of Part of the Districts of Wide Bay and Burnett,"‡ gave a stratigraphical description of the Gympie Gold Field.

The Rev. W. B. Clarke, in his "Sedimentary Formations of New South Wales,"§ gave a list of fossils "capable of identification," from Gympie. These fossils, however,

\* Brisbane : by Authority : 1868.

† Quart. Journ. Geol. Soc., xxviii., p. 289 (1872).

‡ Brisbane : by Authority : 1875.

§ Fourth Edition, 1878, p. 20.

received from Mr. Clarke only generic names, as follow :—*Nucula*, *Fenestella*, *Solarium*, *Spirifera*, *Orthonota*, *Edmondia*, *Stenopora*, and *Producta*. In an Appendix\* to Mr. Clarke's work, Prof. De Koninck added *Spirifer Strzeleckii*, De Kon., to the Gympie list.

In the Chapter on the Devonian Rocks I have already given my reason for transferring large areas of the rocks hitherto regarded as Devonian to the Gympie Formation. As an example of extreme metamorphism of stratified rocks, presumably of the Gympie Formation, Mr. Samuel Stutchbury's description† of the Glasshouse Mountains in Moreton Bay may be quoted in this place.

"The special forms and characteristics which the Glasshouse Mountains present are peculiarly interesting. At first sight, hand specimens might be taken for a fine-grained granite; but on examining these *en masse* and carefully viewing all the attendant circumstances, there can be no doubt that they are metamorphic sandstones. It is evident that no granite masses could have been projected in the form they now assume; they must have been surrounded by some supporting material such as the continuation or extension of the same strata would give, now removed by denudation. Upon careful examination lines of stratification can yet be traced. The largest of the mountains, 'Beerwah,' presents precipitous faces, especially on the northern and eastern sides, exhibiting semi-basaltic columns leaning from the base towards the centre. The sandstone rock adjacent is, in many instances, composed of minute crystals of quartz, each crystal being slightly abraded. In other instances it contains mica (similar to our Old Red Sandstone and Pennant Grits at home), and much ferruginous matter; whilst Beerwah itself appears in composition, as already stated, like a granitell with a few crystals of albite superadded." . . . "We can easily imagine that at a period subsequent to the Coal Measures there were as many foci of heat as there are now mountains, without the pyrogenous rocks having the power to burst through the accumulated strata of sandstone (Beerwah being from 700 to 800 feet above the level of the plain upon which it stands), but sufficient, by their heat, to induce a metamorphosis in the superincumbent sandstone, giving origin to the crystals of felspar, and causing a solidification of the material, which has to a degree protected it; while those portions of the unchanged surrounding sandstones have been removed to the extent observed between the level of the plains and the tops of the existing mountains."

These same mountains have, however, been described by a later observer, the Hon. A. C. Gregory,‡ as "remarkable outbursts of porphyritic rocks."

The late Mr. D'Oyly H. Aplin noted in 1867§ the occurrence of branched corals and crinoidal stems at Elbow Creek, Lucky Valley, in blue slates, within a series of slates, sandstones, and calcareous grits. Above the slates Mr. Aplin noted also calcareous grits with shells and casts of various Brachiopoda, Gasteropoda, and bivalves. Of these only *Productus* and *Spirifer* were mentioned, even by their generic names. Mr. Aplin regarded the fossiliferous series as Silurian, and remarked of the fossils that "in general aspect they resemble the fossils of the diorite slates at Gympie," (p. 5). To this latter statement I should attach greater weight than to the determination of two genera of Brachiopods, which range up to a much later date than Silurian. I could even believe, without difficulty, in the absolute identity of the Lucky Valley Beds

\* Appendix xvi. "C," p. 138.

† New South Wales Geological Survey. Fourteenth Tri-monthly Report, dated Durandin, 1st August, 1854. Legislative Council Papers, N.S.W., 19th September, 1854.

‡ Report on the Geology of Part of the Districts of Wide Bay and Burnett. Brisbane: by Authority: 1875.

§ Report on the Auriferous Country of the Upper Condamine, &c. Brisbane: by Authority: 1867.

with those of the Gympie Formation, especially as similar slates containing corals and crinoid stems have proved to be quite characteristic of the Gympie Formation, as developed in the Rockhampton District.

Mr. A. C. Gregory, in his "Report on the Geological Features of the South-eastern Districts of Queensland,"\* refers to casts of *Spirifer* "found in the Devonian slates and sandstones," at Lucky Valley and the head of Rosenthal Creek, "and also in the limestones and other beds of this series near Rockhampton."

From this meagre evidence, I regard the slates, &c., to the west and south of Warwick as belonging to the Gympie Formation rather than to the Devonian.

Mr. Aplin, in the report above quoted, frequently refers to the lithological resemblance of the slates, &c., of the Moreton Bay District, north of Brisbane, to the Gympie rocks, which, although he regarded them as Devonian, are now relegated to the Permo-Carboniferous. Abundant evidence will be noted in the following pages in favour of transferring the greater part of the stratified rocks between this region and Rockhampton, from the Devonian to the Gympie Formation. If these slates, &c., are of Permo-Carboniferous age, it is probable that so likewise are the slates, schists, and quartzites extending from Brisbane to the Border; but in the meantime, in the absence of direct evidence, these are still left on the map as of "undetermined age."

As in all probability the strata on the New South Wales side of the Border, provisionally mapped as "Upper Silurian or Siluro-Devonian," are continuous with those of Lucky Valley, we look to the work of New South Wales geologists in that region for light on the subject. Mr. (now Professor) T. W. Edgeworth David, in his exhaustive Memoir on the "Geology of the Vegetable Creek Tin-Mining Field,"† in referring to some Polyzoa, Encrinurites, Lamellibranchiata, and univalves found by him in the Parish of Arvid, confesses (p. 54) that "these fossils prove the beds to be of marine origin, but do not afford conclusive evidence as to their age."

The Writer in 1886 made a partial survey of the Gympie Gold Field, and a large collection of fossils. The Geological Survey Museum and the Queensland Museum both contain a considerable collection of fossils from the same locality.

As my Colleague has carefully gone over the collections and the whole literature of the Palæontology of the Gympie Gold Field, it is unnecessary for me to allude here further to the very puzzling lists of fossils furnished by early writers. The stratigraphical information also furnished by the Authors above referred to, although in many instances valuable, may be regarded as superseded, or added to and brought up to date, by the exhaustive Report of Mr. William H. Rands, "On the Gympie Gold Field."‡

The most important part of the Gympie Gold Field (*see Geological Map, Pl. 48*) is comprised within a strip of country on the northern bank of the Mary River, about two miles in length, with an average breadth of about three-quarters of a mile, extending from the town of Gympie southward to the Monkland. This area, it will be seen from the map, is bounded on the north, south, and west, by faults. "This part of the field presents a series of alternations of different kinds of sedimentary strata with some intrusive igneous rocks, and also some of volcanic origin. Taking the average dip at 22°, there must be somewhat over 2,000 feet in thickness of such strata.

"The rocks of which these beds are composed consist chiefly of greywackes, altered sandstones, grey and black carbonaceous shales, grits, conglomerates, breccias, and limestone. Interbedded with these are amygdaloidal volcanic rocks and volcanic

\* Brisbane : by Authority: 1879, p. 7.

† Mem. Geol. Survey N. S. Wales, Geology No. 1, 1887. Sydney : Government Printer.

‡ Brisbane : by Authority: 1889.



ash. There are also sheets of an intrusive 'greenstone,' which has undergone great alteration. Most of the sedimentary rocks are more or less pyritous, some of the shales especially being full of small cubical crystals of iron pyrites, and most of them, too, are calcareous. This is especially the case with the sandstones, greywackes, and conglomerates, and with some of the shales. The faces of the 'joints' or cracks in the rocks are almost invariably coated with carbonate of lime in the form of calcite.

"The strata dip with great regularity at an average angle of from 20° to 22°. On the northern portion of the field the direction of dip is, as a rule, a little to the north of east; on the southern portion it is to the E.S.E.

"While many of the rocks have undergone but little alteration, others have been greatly altered, almost to the obliteration of their original character. These rocks have become indurated and in some cases semi-crystalline, and it is only with difficulty that the latter can be distinguished from the true igneous rocks. Speaking generally the rocks which occupy the lowest position in the series, and whose outcrops occur, therefore, at the western portion of the field, have undergone the greatest alteration; although in the upper part of the series rocks which have been considerably altered alternate with those which have undergone but slight alteration.

"Perhaps the most typical section of the Gympie rocks is that which is taken in a line (A-B) across the field from near the Railway Station to near Channon-street Bridge (Pl. 54, 55). In the following list of rocks in the section the thicknesses have been calculated from the outcrop of the strata at the surface, as very little mining is going on now in this part of the field, and the old workings are generally inaccessible. The figures are therefore only approximate, and the thicknesses vary greatly on either side of the line of section:—

	Ft.	in.
Blue impure limestone (fossiliferous)...	138	6
Coarse pebbly conglomerate with sandstone (very thick at station) ...	360	0
Laminated sandstone ...	55	0
Shales (fossiliferous) ...	56	4
Coarse altered conglomerate ...	10	0
Shales with beds of thin-bedded sandstone ...	50	0
Hard grey greywacke ...	20	0
Shales (fossiliferous) ...	66	0
Coarse pebbly conglomerate ...	26	3
Laminated fine-grained sandstone ...	20	0
Angular grit (probably a volcanic agglomerate) ...	26	4
Greenish and highly fossiliferous sandstone...	33	0
Greenish semi-crystalline greywacke...	25	0
Shales, so-called 'First Bed of Slate' ...	15	2
Hard grey greywacke ...	19	8
Coarse altered conglomerate ...	20	0
Greenish semi-crystalline greywacke...	16	6
Sandstone and coarse altered conglomerate ...	20	3
Shales, so-called 'Second Bed of Slate' ...	13	0
Hard altered crystalline greenstone—'Gympie greenstone' ...	297	0
Green and purple altered chloritic rock; partly amygdaloidal volcanic rocks, partly volcanic ash, and partly stratified ...	315	0
So-called 'Third Bed of Slate' with a thickness of grey-green, fine-grained greywacke, and underneath altered chloritic rocks like those above ...	286	0
Limestone...	20	0
	1,909	0"

At the Monkland the bed of impure limestone which lies at the top of the auriferous series "is considerably over 200 feet thick (probably about 230 feet). It can be seen in the high northern bank of the river close to the small gully on the No. 2 Great Eastern ground, but beyond that point I have been unable to trace it in a southerly direction. The conglomerate that underlies the limestone is exceptionally thick where the section-line crosses it. It is made up of pebbles ranging from 1 inch up to 8 inches in diameter, and consisting chiefly of greywacke, sandstone, and quartz. In places it passes into sandstone.

"I now come to the consideration of the beds of 'Black Slate,' in connection with which the richest deposits of gold have been found in the reefs. In the true sense of the term these beds are 'shales,' and not 'slates,' the fissility or lamination coinciding with the planes of bedding.

"The shales are at times laminated, sometimes thin-bedded, but generally thick-bedded. They pass in places into aluminous sandstone, locally called 'Black Rock.' The shales are carbonaceous, slightly calcareous (their joints are always coated with calcite), and generally they are pyritous. Thin sections examined under the microscope show them to be made up of fine carbonaceous mud, with small rounded and a few semi-circular specks of quartz and small cubes of iron pyrites.

"There are four well-defined zones of slate. The uppermost one, which may be termed '*Phoenix or Monkland Slate*,' is about 200 feet thick; in it there are a few thin beds of sandstone and greywacke. By far the greater part of the gold has been taken from the reefs when passing through this bed, in which fossils are very numerous, the commonest forms being—*Fenestella*, *Protoretepora*, *Spirifera*, *Productus cora*, *Strophomena rhomboidalis*, *Ariculopecten*, *Pleurotomaria carinata*, and *Orthoceras*.

"The next beds of auriferous shale in descending order are what have been termed by the miners the '*First and Second Beds of Slate*.' These beds vary from 10 to 20 feet each in thickness, and are about 100 feet or more vertically apart. They are rich in iron pyrites, and are generally of a fissile structure. On weathering, they become friable and brown in colour, owing to the amount of ferruginous matter in their composition. Very rich deposits of gold have been obtained from reefs in contact with these shales, especially during the early days of the field. The Lady Mary, Caledonia, California, New Zealand, Crown, March, Hilton, and Hamburg Reefs carried rich gold in these beds. So far as my observation went, these two beds are not fossiliferous.

"The '*Third Bed of Slate*' lies about 400 feet below the second. It is quite different in its character from that of the three zones lying above. It is always, too, associated with a greenish-grey, fine-grained, laminated greywacke, possessing a flinty or splintery fracture. This greywacke is of great thickness. The Ellen Harkins shaft has passed through over 300 feet, and the Wilmot shaft about 200 feet of it. Thin sections of this greywacke show, under the microscope, a very fine-grained ground-mass, with small rounded and subangular particles throughout it. Beds of the black carbonaceous shale occur at various depths in this greywacke, three such layers occurring in the Ellen Harkins; but besides these distinct beds there are patches of a black rock in it, which, under the microscope, show a similar structure to the greywacke; it is in fact a black carbonaceous greywacke, the one rock passing insensibly into the other. The whole thickness of greywacke and shales forms the fourth auriferous zone, and is known on the field as the '*Third Bed of Slate*.' The gold in this bed is exceedingly patchy, and many claims have been working on it without success. It was, however, in this shale, at a depth of 600 feet, on the Ellen Harkins Reef, that perhaps the richest patch

of gold yet met with on Gympie was obtained. In the outcrop of this bed, on the south side of the river near the No. 2 South Ellen Harkins, the fossil *Protoretepora ampla* occurs. This is the only spot in which I have seen fossil remains in this bed.

"Another bed of slate is reported to exist below this, in one or two claims—The Eldorado for instance." Mr. Rands was, however, in some doubt about its occurrence.

"A point of great interest is the occurrence of large isolated boulders in the Upper or Thick Bed of Shale. As examples of these, I may mention one from the No. 1 North Phoenix at a depth of 370 feet, at a point where the shale has passed into a fine aluminous sandstone. This boulder consists of a fine siliceous greywacke, and its dimensions are  $13 \times 10\frac{1}{2} \times 5$  inches. Another, in the shale in the Phoenix Golden Pile, is of a coarse greywacke, containing ill-defined crystals of felspar and crystals of iron pyrites; this was  $8\frac{1}{2} \times 5\frac{1}{2} \times 3\frac{1}{2}$  inches. It would be difficult to say how far these boulders have travelled, since these greywackes are not only common on the field itself, but also throughout the Carbonifero-Permian and Devonian Rocks, which occupy a large area in this district. The presence of such boulders in a rock which was laid down as a fine silt would point to the conclusion that they were dropped from floating ground-ice, for any current of sufficient strength to carry along these boulders would have washed away the lighter materials of which the shale is composed.

"A curious rounded boulder of granite, about 6 inches in diameter, was found enclosed in the O'Connell Reef, in the O'Connell Prospecting Claim, at a depth of 240 feet. The granite is coarse in the grain, and is composed of pink orthoclase and quartz, with a few specks of decomposed mica. This boulder must have been introduced into the reef from the surface while the fissure remained open. It must have travelled some miles, for I know of no granite nearer than that of the Black Snake Range, which is about 20 miles west of Gympie.\* The granite of which the boulder is composed is very different to that from the range, being much coarser and containing much more quartz. This is the only instance of a boulder of the kind having been found. It is probable that at the time it was deposited the country was submerged, and that the boulder was carried, probably on floating ground-ice, and dropped into the position in which it was found, while other similar boulders, which would have been dropped on the sea-bottom, have since been removed by denudation. Had it been conveyed by any land stream, the fissure in the reef would probably have been filled up with others brought along with it.

"The greenish fossiliferous sandstone just above the 'First Bed of Slate' can be traced from White's Gully to the Lucknow, and then again at the Two-Mile. It is a bed easily recognisable, serving well in determining the horizon of beds near it. In some places it is one mass of fossils. Amongst these are—*Stenopora*, *Protoretepora*, *Fenestella*, *Spirifera*, *Conocardium*, *Aviculopecten multiradiatus*, *Edmondia*, *Pleurotomaria carinata*, &c.

"The 'Gympie Greenstone' is below the 'Second Bed of Slate.' As it has been such a stumbling-block to the miner I must allude to it at some length. The occurrence of gold in rocks below it has frequently been spoken of as contrary to all preconceived ideas and principles, and the late Mr. Aplin's Report is quoted in support of this. Mr. Aplin says in reference to this 'greenstone':—"Whether in irregular-shaped masses or broad dykes, this rock occurs at intervals over a large portion of the area of this goldfield, but it is most prominently developed within a zone of half-a-mile in width, having a longitudinal direction of N. 60° W., and embracing the space from the Lady Mary hill to that on which the Gympie township commences. It is in the decomposed

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\* "I have seen granite near Glastonbury, about 10 miles from Gympie, but it is of a different character to that of which this boulder is formed."

portions of this rock, which weathers brown and becomes argillaceous, though maintaining its compactness, that the quartz veins traversing it are found to be so highly productive. In its ordinary condition it is excessively hard and is the most formidable obstacle the miners have to contend with, some from the very surface, and others at varying but at comparatively shallow depths.\* And further on in the same report he says:—‘Up to the present time scarcely any of the reefs have been opened up to a greater depth than between 60 and 70 feet, and but little stone has been raised below 30 or 40 feet within the limits of the belt of greenstone to which I have before referred. From the crystalline character and extreme hardness of this rock, which I do not think is likely to become softer as it is followed downwards, there is little probability that the reefs traversing it can be profitably mined to any great depth, in fact in one or two cases the tendency to become narrowed, and impoverished also, is already apparent; and though, perhaps, they may not be altogether “pinched out,” the quartz veins will, doubtless, become so attenuated that it will be no longer profitable to work them.’

“Mr. Aplin’s remarks with reference to the unproductiveness of the reefs in the ‘greenstone’† have been fully borne out by later experience, since none of the reefs contain payable, if any, gold at all, when passing through it. The mistake he made was coming to the conclusion, without sufficient evidence, that the greenstone was in the form of ‘an irregular-shaped mass or broad dyke,’ whereas future development has proved it to be in the form of an intrusive ‘sheet.’ Had it existed as a dyke or irregular mass, one would have expected it to extend to any depth that the miner could have reached, and it would have been useless to have attempted to follow the reefs into it. The miner, in the early days, abandoned the reefs as soon as the greenstone was reached, and he added also to his difficulty by calling every rock ‘greenstone’ which was of a green colour.

“It was not for some years, when the upper levels were nearly worked out, that deeper sinking was, at last, resorted to, and that auriferous beds were found lying beneath the greenstone. In the case of an igneous rock, such as this, intruded in the form of a ‘sheet,’ parallel with the planes of bedding, there is no reason why beds favourable to the occurrence of gold should not exist below as well as above it. The greenstone is intimately associated with other rocks which are, undoubtedly, of sedimentary origin, but which have by alteration become so semi-crystalline that it is at times difficult to distinguish between them.

“Doubts have been expressed as to whether the greenstone is an igneous rock at all; however, from its relation to the surrounding rocks, and the baked appearance some of the rocks in contact with it have, there can be little doubt but that it is of igneous origin, and that it is an intrusive sheet which, while generally conforming to the bedding of the rocks, at times, both at its upper and under surfaces, break across their planes of bedding. This feature can be well seen in the Smithfield United and the No. 5 North Glanmire Claims. The ‘greenstone’ varies from a dark to a cabbage-green in colour; it is very hard and breaks with a somewhat conchoidal fracture. In the microscope, crystals of plagioclase felspar are discernible; also very much altered greenish crystals, either altered hornblende or augite, changing into viridite; opaque crystals of iron pyrites and small grains of magnetite. The rock has undergone too much alteration to name it definitely. It was probably either a diorite or dolerite.

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\* Report from the Government Geologist for South Queensland on the Geological and Mining Features of the Gympie Gold Field. Brisbane: by Authority: 1868.

† Mr. Rands seems to have misunderstood Mr. Aplin’s remarks, which distinctly imply that the reefs, so far from being unproductive, were most productive when traversing the greenstone, or at least its decomposed portion. Mr. Aplin, however, was greatly in error as to the fact. (R.L.J.)

"Analyses of this 'greenstone' are given by Mr. Daintree in his paper on the "Geology of Queensland,"\* and by Professor Liversidge.† They are:—

					DAINTREE.		LIVERSIDGE.
					Per cent.		Per cent.
Silica ...	...	...	...	...	50.500	...	54.952
Alumina ...	...	...	...	...	18.485	...	16.643
Ferric oxide ...	...	...	...	...	1.470	...	2.410
Ferrous oxide ...	...	...	...	...	6.440	...	7.849
Lime ...	...	...	...	...	8.800	...	8.645
Magnesia ...	...	...	...	...	8.530	...	trace
Potash ...	...	...	...	...	0.635	...	1.540
Soda ...	...	...	...	...	1.655	...	6.647
Sulphur ...	...	...	...	...	0.190	...	...
Manganese protoxide ...	...	...	...	...	...	...	trace
Carbonic acid ...	...	...	...	...	0.820	By diff.	1.314
Water (constitution) ...	...	...	...	...	1.600		
Water (hygroscopic) ...	...	...	...	...	0.850		
					99.975		100.00
					Sp. gr. 2.752		Sp. gr. 2.860

"Mr. Allport, of Birmingham, to whom Mr. Daintree referred this rock for microscopic examination, says:—'This is diorite, containing hornblende, triclinic felspar, a little brown mica (biotite), and pyrites.'

"The micro-photograph of the section in Professor Liversidge's paper shows a rock made up of particles of other rocks, with fragmentary crystals of felspar, augite, and magnetite, mingled with chlorite. This section does not resemble those cut by myself and described above; and I am under the impression that the rock described by Professor Liversidge as an altered ash or breccia is one of the green fragmentary rocks.

"Although the reefs actually in contact with the 'greenstone' have become impoverished, and do not contain gold in payable quantities, it nevertheless appears to have had a favourable influence on the auriferous character of the shales in its vicinity, for it is only in these beds that the reefs have contained payable gold.

"The reefs, in the great mass of shales which lie above, and to the east of the upper bed of limestone, have not, so far, proved payable; and, so far as my observation goes, these shales are, with the exception of one or two small dykes and sheets of diorite and porphyry, entirely free from intrusive igneous rocks.

"Above and below the lower or third bed of shale, there is, as seen in the section, a great thickness of altered greenish and purple chloritic rocks. I have examined the rocks carefully, and find that many of them are of volcanic origin; some of them are fragmentary (altered ash or breccia); others have been ejected in a molten condition, as in the case of a purple and green amygdaloidal rock, which is met with in many parts of the field. I examined a thin section of this rock under the microscope, and would pronounce it to be an amygdaloidal diabase, very much altered; the cavities are generally filled with carbonate of lime, but sometimes with hydrous silica. In the Lady Flora, small specks of native copper have been seen in this rock, at a depth of about 140 feet. The speck of copper in a specimen I found on the mullock heap was surrounded with oxide of iron. The copper may have been reduced from either the sulphide or oxide of copper by reducing gases given off during the cooling of the rock.

\* Quart. Journ. Geol. Soc., xxviii., p. 293.

† Journ. R. Soc. N. S. Wales, xvi., p. 45.

"Below these rocks, again, is a thin bed of bluish limestone, seen in Nash's gully, close to its mouth, near the river bank, in the Surface Hill shaft, and also on the south side of the river near the Normanby Bridge. A few yards to the west of the outcrop of limestone a thick mass of shales occurs, dipping very steeply to the south-west, or in a direction just opposite to that of the Gympie rocks. These shales crop out in the road cutting leading down to Channon-street Bridge. The shales would appear to be outside of the auriferous area, no payable reefs having yet been found in them. They are separated from the Gympie beds by a 'strike-fault' running nearly north and south, the position of which is somewhere between the outcrops of the lower bed of limestone and that of the shale in the road cutting. This fault makes all chances of predicting what strata will be met with below the lowest known beds impossible, for such strata, instead of cropping out at the surface, would come up against the fault.

"The shales extend westwards for four or five miles, when they are covered by a narrow belt of Desert Sandstone. These shales are black in colour, but, unlike the Gympie auriferous shales, they contain but little pyrites."

One of the faults already mentioned is the "Smithfield Crosscourse," which divides the area above described from the Monkland and Glanmire portion of the field further to the south. It runs E. 16° N., and has a downthrow to the north of about 530 feet. "None of the reefs on the south side of this fault have been identified with those on the north; on the south side, however, they would lie away to the west. Taking the average underlie of the Phœnix Reef at 27°, and allowing for a downthrow of 550 feet, it would bring it nearly opposite the Ellen Harkins Reef, but it is impossible to identify them with any certainty."

On a line of section (E F, Pl. 57) drawn nearly east and west on the south side of the Smithfield Crosscourse, "We meet with a few marked changes, chief amongst which is the absence of the first and second beds of slate. At some distance underneath the thick beds of limestone and pebbly conglomerate are the upper shales identical with the Phœnix shales on the Phœnix line of reef; this is the bed in connection with which the Smithfield, Columbia, Glanmire, Monkland, Great Eastern, &c., &c., lines of reef have been worked; below the shales is an altered calcareous semi-crystalline greywacke, then 'greenstone,' and below that again is the 'Third Bed of Slate,' with its fine-grained greenish greywacke, with which it is always associated; the two thin beds, known as the 'First and Second Beds of Slate,' which have been worked in the Hilton, Golden Crown, and Nos. 7 and 8 South Lady Mary, &c., being absent, unless the thin bed—in places not much thicker than a sheet of paper—in which the rich gold was obtained in the Wilmot and Russell Reefs in the Wilmot Extended Mine represents one of them. It is, however, of small extent, and has not been traced south of that claim. The explanation of their absence appears to me to lie in the fact that the two beds in question are thinning out to the east on the northern side of this fault. The greywacke in which the 'Third Bed of Slate' occurs is thicker here than on the northern part of the field.

"Still further south—that is to say, south of the South Ellen Harkins and Wilmot Claims—we meet with another important change. Here the Third Bed of Slate has not been met with on the northern side of the river, although the outcrop of this bed, or of one very similar, may be seen a short distance west of the shaft of the No. 2 South Ellen Harkins Leasehold, which is situated on the southern side of the river; so that, up to the present, no auriferous beds have been met with in this southern portion of the field below the thick Upper or Monkland Shales, and yet two of the deepest shafts are situated in this part of the field—namely, those of the Inglewood and the Great

Monkland (Aurelia), which are down 1,200 and 1,300 feet respectively. Had it continued with its regular strike and dip, the 'Third Bed' would have been met with in the former shaft at a depth of about 750 feet, and in the latter at about 900 feet. The country passed through in the two shafts is very similar, consisting chiefly of altered stratified rocks of a grey or greenish colour. The lines of stratification are well marked in the finer grained rocks. Some of the deepest rocks are very much altered and are very chloritic, and resemble the lowest beds on the northern side of the field. It is difficult to understand how the very great thickness of the fine laminated greywacke, with shales, which occurs in the Union, the South Ellen Harkins and Wilmot, the Ellen Harkins, the Wilmot Extended, &c., &c., would thin out and disappear altogether in so short a distance; and it is far more probable that a fault occurs between the two points; if so, it must run in a direction so as not to disturb the Upper Shales, for they are continuous throughout the Smithfield, Glanmire, and Monkland Claims. The only direction that such a fault could run in would be about north-north-east, or about parallel with that in the Monkland and Abyssinia.

"About thirty chains west of the Normanby Bridge the lower bed of limestone can be seen for a short distance crossing Purcell's selection."

About two and a-half miles further south-east, near the Dawn Shaft, a bluish limestone is seen. It can only be traced for a few yards, and the direction of its dip is uncertain. "Immediately west of it are the thick masses of shale which occur everywhere west of the [auriferous] Gympie beds. It would appear, therefore, that this limestone must be a continuation of the lower bed." . . . "The commonest forms of fossils in this limestone are:—*Protoretepora*, *Spirifera*, *Martinia glabra*,\* *Aviculopecten*, and *Productus brachythærus*.† The only coral from Gympie ‡—a *Cyathophyllum*—was from this bed."

"In the No. 2 South Ellen Harkins Leasehold the laminated greywacke with bands of black shale—the Third Bed of Slate—is met with at a depth of 275 feet; east of that are altered green and purple rocks, while a chain to the west of the shaft is the outcrop of the beds of shale containing *Protoretepora*."

North of the area whose structure has been illustrated by the first section (A B), a strip of country about twenty-seven chains in width extends from the railway line near the head of Commissioner's Creek westward to Gympie Creek. This area is bounded on the north and south by two parallel faults, the southmost having a downthrow to the north and the northmost a downthrow to the south. Between these faults a cuneiform mass of strata has been let in. The strike of the beds is parallel to the two faults—i.e., forms an angle of 135° with the strike of the beds seen both to north and south. "These strata apparently belong to the overlying shales" [shales overlying the Gympie auriferous rocks], "and consist of grey shales, with a bed of white crystalline limestone in which the fossil *Stenopora* occurs numerously. This bed of limestone, therefore, not only dips in a different direction, but is of quite a different character, and contains different fossils to that which forms the upper part of the Gympie auriferous beds. A similar limestone was cut in the shaft of the No. 1 North Lucknow, after passing through 115 feet of laminated shales. These beds contained *Strophomena rhomboidalis*, and *Martinia glabra*."§ The dip of the strata between the two faults is about 15°

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\* Not included in my Colleague's list, and therefore ignored.

† Not included in my Colleague's Gympie list, but included in his list of fossils from Encrinite Creek, Fenestella Hill, Stanwell, Kariboe Creek, and Yarrol = Gympie beds.

‡ Mr. Rands is in error here. He himself quotes *Stenopora* from above the "First Bed of Slate," See *antea*, p. 77. (*R.E. junr.*)

§ Not included in my Colleague's list.

to S. Several shafts have been sunk between the two faults, but apparently to no purpose, as the horizon of the strata met with was probably not recognisable owing to the coming together of the two faults.

North of this area the upper limestone is again seen with its normal strike from south-east to north-west, and a dip of  $21^{\circ}$  to  $23^{\circ}$  to N.E. Mr. Rands has mapped it from this point continuously to a point about three-quarters of a mile east of O'Leary's Crossing of the Mary River on the Kilkivan road.

"A very cursory glance is sufficient to show that" [at the Two-Mile] (*see* Pl. 58) "we are dealing with very similar beds" [to those of the Central District, Gympie], "while a closer examination shows that the order of superposition of the principal beds is the same in both places, and that the strata of the Two-Mile are an actual continuation of the Gympie Beds." \*

"The strata dip to E.N.E. at an average of about  $20^{\circ}$ . [*See* Section A B, Pl. 54, 55.] Beneath the thick mass of shales which lie away to the east we have, as on Gympie, the bed of impure limestone, here about 150 feet thick. Immediately below this is the bed of coarse pebbly conglomerate, with some thin beds of sandstone. Below this again can be seen the outcrops of shales with beds of laminated sandstone—the equivalent of the 'Upper or Phoenix Slates'; then, at some distance below this, is the greenish and highly fossiliferous sandstone, identical with and containing the same species of fossils as the bed which, on Gympie, is traced from White's Gully to near the Lucknow. A few feet beneath this is the 'First Bed of Slate'—a bed of black graphitic shale about 20 feet thick. The Hibernian and Homeward Bound Reefs were worked in this bed, and rich but patchy deposits of gold were obtained. About 150 feet below this is the 'Second Bed of Slate,' about 15 feet thick, which has been worked in the Bristol and London Claims. Between these two beds are altered greenish greywackes, one of which is an altered volcanic ash. It is made up of a number of angular particles in a fine matrix. There is also a peculiar grit or fine conglomerate, made up almost entirely of rounded and flattened particles of about the size of peas. Below the Second Bed of Slate is a hard crystalline 'greenstone' of a similar character, and occupying the same position as on Gympie; then below are altered greenish chloritic rocks, with an amygdaloidal volcanic rock (amygdaloidal diabase). At a depth of 530 feet below the Second Bed is the fine laminated greenish-grey greywacke, with which is associated the black shale known as the 'Third Bed of Slate,' precisely similar to that met with in the Ellen Harkins, &c. Good gold was got in the Chatsworth Reef in this bed close to the surface, and the London shaft was in it from 631 feet to near the bottom (736 feet), when they passed into green chloritic rocks again. On comparing this section with that from the Railway Station to Channon-street Bridge, their close agreement will be noticed. The Two-Mile can without hesitation be pronounced an actual continuation of the Gympie auriferous belt.

"The Two-Mile is situated some distance further away to the west than it would have been had the Gympie Beds continued without any disturbance. The large fault, however, which occurs between the two places has brought about, on a still larger scale, a repetition of what has taken place between the Smithfield and Phoenix Claims. The fault shifts the outcrop of the limestone and other rocks to the west for a distance of nearly 70 chains, which, allowing for a dip of about 1 in 3 to the east, gives a downthrow to the north of about 1,200 feet.

"The gold in the reefs at the Two-Mile is in rich patches, and not so continuous as on Gympie. This may be owing to the country, which is reported to be much

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\* Mr. Rands uses the term "Gympie Beds" in the restricted sense of the auriferous strata of the Central District, Gympie.



broken or disturbed by small faults. Rich gold was obtained from the London, Bristol, German, Homeward Bound, Hibernia, and Chatsworth Reefs in the 'First and Second Beds of Slate.'

"The outcrop of the beds underlying the limestone seems gradually to disappear to the north; thus the outcrop of the 'Third Bed of Slate' is at a much less distance west of that of the limestone at the Chatsworth than at the London, while beyond the Chatsworth I have been unable to trace the beds at all. Their absence might be due either to the thinning-out of the beds towards the north, or to a 'strike-fault,' the downthrow of which increases towards the north, the effect of which would be the sinking of the intermediate strata below the surface. The thickness of the strata is so great that it is scarcely possible they would have thinned out to nothing in so short a distance, and I think, therefore, that the latter explanation is the more probable.

"About five miles north-west of Gympie, in the old Timber Reserve, deposits of stibnite (sulphide of antimony) have lately been discovered in the limestone. Specimens of the fossil *Protoretepora* occur with its fine markings beautifully picked out in stibnite. *Martinia glabra*\* and *Productus brachythærus*† are also very numerous.

"The country for some miles, both east and west of the auriferous rock of Gympie, consists chiefly of laminated grey shales, with interbedded fine-grained sandstones. These shales are bounded on the west by hardened silicated or jasperised sandstones, beyond which, again, are the granite and serpentine ranges of Kilkivan and the Black Snake. On the north and east they are bounded by the coal-bearing beds of the Tiaro district. The general dip of the shales is east or north-east. In places they dip to the south. At Tamaree there is a bed of white crystalline limestone, from which I obtained a few fossils, among which were *Aviculopecten*, *Spirifera*, and crinoid stems. The limestone is being quarried and burnt for use in the Yengarie Sugar Refinery.

"In several places the shales are covered with a coarse sandstone or freestone belonging to the Desert Sandstone formation. The shales are intersected here and there by dykes and sheets of diorite and sheets of porphyry.

"Reefs have been worked in several places in the outside shales, but, so far, without much success; some of the crushings have been good, but the cost of carting the quartz in to Gympie has been a great handicap."

I have quoted from Mr. Rands' Report at great length, with the object of recording data for the future comparison of strata of like age in other districts.

The following is Mr. Etheridge's list of the fossils which have been obtained from the type district of Gympie itself:—

- Cordaites australis*, McCoy?
- Stenopora gimpiensis*, Eth. fil.
- Fenestella fossula*, Lonsd.
- " *sp. ind.*
- Polypora*? *Smithii*, Eth. fil.
- Protoretepora ampla*, Lonsd.
- Rhombopora*? *laxa*, Eth.
- Spirifera vespertilio*, G. B. Sby.
- " *trigonalis*, var. *acuta*, Eth.
- " *dubia*, Eth.
- " *Stokesii*, König.
- " *Strzeleckii*, De Kon.

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\* Not included in my Colleague's list.

† Not included in my Colleague's Gympie list, but included in his lists of fossils from Encrinite Creek, Fenestella Hill, Stanwell, Kariboe Creek, and Yarrol = Gympie Beds.

*Martinia (Martinopsis ?) subradiata*, G. B. Sby.

*Strophomena rhomboidalis*, var. *analoga*, Phill.

*Productus cora*, D'Orb.

*Aviculopecten limæformis*, Morris ?

„ ? *imbricatus*, Eth.

„ *multiradiatus*, Eth.

*Mytilops ? sp. ind.*, Pl. 14, f. 20.

*Astartella ? rhomboidea*, Eth. fil.

*Cypricardella Jackii*, Eth. fil.

*Conocardium australe*, McCoy.

*Chænomya Etheridgei*, De Kon. ?

*Edmondia ? obovata*, Eth. fil.

*Sanguinolites concentricus*, Eth.

*Pleurotomaria carinata*, J. De C. Sby. ?

*Conularia tenuistriata*, McCoy.

„ *sp. ind.*

*Orthoceras*, *sp.*

*Goniatites*, *sp. ind.*

Mr. Rands further mentions having discovered in the Upper Limestone bed in the North Smithfield Shaft “a specimen of an ‘Ichthyodorulite’ or fin-spine of a fish, belonging probably to the genus *Otenacanthus* of the order *Placoidi* (Agassiz), sub-order *Cestrphori*” . . . and adds, “I have since found another specimen of the above in shales in the Deep Creek.”

## MINES IN CONNECTION WITH THE GYMPIE FORMATION IN THE TYPE DISTRICT.

### GYMPIE GOLD FIELD.

Among the goldfields of the Colony, Gympie ranks after Charters Towers and Mount Morgan. The field having already been described in considerable detail in this Chapter, it is only necessary in this place to give the following table. Exhaustive details will be found in Mr. Rands' First and Second Reports \* on the Field.

YIELD OF GYMPIE GOLD FIELD.

Year.	REEF GOLD.		Alluvial Gold.	Total Gold.	Remarks.
	Stone Crushed.	Gold therefrom.			
	Tons.	Oz.	Oz.	Oz.	
1867 to	}			544,914 <sup>1</sup>	<sup>1</sup> Deduced from figures in Report of Department of Mines for 1884, p. 11.
1875		...	...		
1876		...	...	36,232	
1877		19,331	43,854	43,854	
1878		22,358	40,320	1,244 <sup>2</sup>	<sup>2</sup> Includes pyrites, tailings, and alluvial.
1879		26,383	36,799	1,654 <sup>3</sup>	
1880		22,562	39,511	3,561 <sup>3</sup>	<sup>3</sup> Includes pyrites, tailings, and alluvial. (?)
1881		30,066	65,654	2,207 <sup>3</sup>	
1882		44,720	50,162	150 <sup>4</sup>	<sup>4</sup> Alluvial only. (?)
1883		56,980	64,818	Nil	
1884		62,085	112,051	Nil	<sup>5</sup> Pyrites, &c.
1885		84,146	86,832	2,700 <sup>5</sup>	
1886		103,946	88,450	150 <sup>6</sup>	<sup>6</sup> Pyrites, &c. (?)
1887		90,673	96,940	5,209 <sup>3</sup>	
1888		111,962	106,885	234 <sup>3</sup>	
1889		108,317	115,450	140 <sup>3</sup>	
1890		101,831	78,044	322 <sup>3</sup>	
		Total ...	...	1,624,487	

\* Brisbane : by Authority : 1891.

## NEERDIE ANTIMONY MINE.

The history of this mine, which apparently is rich in sulphide of antimony, has been varied by periods of prosperity and depression according to the rise or fall in the price of the metal. The total amount of ore produced from 1873 to 1886 was 930 tons, valued at £11,769. The statistics, however, give the amount of ore *raised* except in the year 1881, when only the amount *shipped* is given.

## YIELD OF NEERDIE ANTIMONY MINE.

Year.					Tons of Ore.	Value.
						£
1873	...	...	...	...	15	157
1874	...	...	...	...	207	2,141
1875	...	...	...	...	60	360
1876	...	...	...	...	18	216
1877	...	...	...	...	101	606
1878	...	...	...	...	27	405
1879	...	...	...	...	4	40
1880	...	...	...	...	Nil	...
1881	...	...	...	...	163	1,965
1882	...	...	...	...	(No return)	...
1883	...	...	...	...	127	2,550
1884	...	...	...	...	198	2,969
1885	...	...	...	...	(No return)	...
1886	...	...	...	...	110	400
Totals					1,030	£11,809

The following description of the mine is taken from a Report by Mr. Bands on the Tiaro District,\* which may be referred to for further details.

"The mine is situated about twelve miles west of Gunalda Railway Station, in the Gympie Shales, south of the Coal Measures. The lodes are in the same series of shales as the Exhibition, Enterprise, and Veteran Reefs—the thick masses of shales which overlie the auriferous beds of Gympie.

"The Neerdie Antimony Mine has been worked, on and off, since the year 1873. The Neerdie Antimony Company—the original owners—worked it from 1873 to 1876; they did not make it pay. Then a man named Ahrenfeldt leased it on tribute from 1876 to 1878, but did very little with it. In 1881 it was leased on tribute to Mr. H. E. King, as managing director of the Wide Bay Antimony and Smelting Company. This company, I am informed, did well by sending ore home direct, even at its low price at that time. They then put up furnaces and flues, and liquated the ore, sending it home as 'crude antimony,' which is merely the sulphide of antimony obtained by a process of liquation; the portion that would not liquate was oxidised and caught in the flues. They did not, however, obtain so high a price for the 'crude antimony' as they were getting for the ore; and this, together with a lawsuit with the original company, as to whether the liquated sulphide was smelted antimony or not—they having to pay a higher tribute for smelted antimony—drove the company into liquidation in 1883. The mine was then idle until 1886, when it was sold on conditions to the Neerdie Antimony and Smelting Company. It was worked by this company until the early part of this year. They took out a large quantity of good ore, but the expenses of the furnaces and liquation, and the low price of antimony at the time, caused them also to go into liquidation, the mine being thrown on the hands of the original owners again.

\* The Coal Measures, Neerdie Antimony Mine, and Teebar and Culgoa Copper Lodes. Brisbane: by Authority: 1890.

"So far as I am able to gather from information supplied to me, about 1,139 tons of ore and 'crude antimony' have been sold from the mine. Of this about 250 tons of ore, won by the original company and by Mr. Ahrenfeldt, fetched a little over £10 per ton. The Wide Bay Antimony and Smelting Company and the Neerdie Antimony and Smelting Company sold 890 tons of ore and 'crude antimony,' at prices varying from £8 15s. per ton to £17 10s. per ton.

"The New South Wales returns for the ten years 1872 to 1881, show that in that colony 1,072 tons of antimony (metal, ore, and regulus; the proportions of each are not given) sold for £28,616, or an average of £26 13s. 9d. per ton. At the present time the price of antimony is higher than it has been for a long time. Quotations in the American Mining Journal are:—

26th July, 1889—Star regulus	...	...	...	£61 to £63 per ton.
Crude antimony	...	...	31	" 33 "
50 per cent. ore	...	...	18	" 20 "

"The ore from the mine is of a good quality and can be 'picked' up to between 50 per cent. and 60 per cent. At the present prices it should pay to work if there is as good ore in the bottom level as there was in the upper ones.

"Up to the present work has been carried on on one lode only, and on but one 'shoot' in that lode. There has not been sufficient prospecting for fresh 'shoots,' nor have the other lodes that are known to exist been sufficiently tried."

J.

## CHAPTER VIII.

### THE PERMO-CARBONIFEROUS SYSTEM—*continued*.

#### THE GYMPIE FORMATION OUTSIDE OF THE TYPE DISTRICT,

INCLUDING YARROL, MOUNT BIGGENDEN, GEBANGLE, MOUNT SHAMROCK, EIDSVOLD, CANIA, RAGLAN, LANGMOEN, CALLIOPE, KOONGAL, ROCKHAMPTON, DEE AND DON RIVERS, ST. LAWRENCE.

**Mineral Areas—viz.,** Kilkivan and Black Snake, Kilkivan Mercury Mines and Mount Coora Copper Mine, Gayndah Gold Fields, Mount Biggenden, Gebangle and Mount Shamrock Gold Fields, Brovinia Gold Field, Paradise Gold Field, Raglan, Calliope, Norton, Cania and Kroombit Gold Fields, Rockhampton Gold Fields (excluding Mount Morgan), Yatton Gold Field, Gooroomjam Diggings, Warwick Gold Fields.

SEPARATED from the Gympie District by the granitic ranges which extend from Kilkivan to the heads of Munna Creek, and the granitic mass of Boolboonda, are some strata from which Mr. Rands has obtained fossils which enable us to place them on the horizon of the Gympie Beds.\* Among these strata beds of limestone and sandstone close to Yarrol Station have yielded *Productus brachythærus*, G. Sby., *P. sp. ind. (a)*, Pl. 13, f. 6, and *Pleurophorus Randsi*, Eth. fil., as determined by my Colleague. Mr. Rands also mentions the following:—*Fenestella*, *Retepora*, *Ceriopora*, *Spirifera* (two species), *Strophomena rhomboidalis*, and another species, *Rhynchonella*, *Aviculopecten*, *Pleurotomaria*, *Mourlonia Strzeleckiana*, Morris, and *Orthoceras*.

A galena lode, in slate country probably of the same age, has been worked about a mile and a-half south of Yarrol Station.

Near the Bismuth and Gold Mine of Mount Biggenden are limestones and siliceous slates, the latter predominating. The limestone has been metamorphosed and has become crystalline. "From the foot of the spur leading up to the mines (about 10 chains) the rock consists entirely of siliceous slates, which dip very steeply to the north-west. Above the mine is a bed of limestone about 70 feet in thickness, and above that again the slates occur, together with an altered sedimentary rock containing quartz, felspar, hornblende, and olivine. Rocks of the same character occur on the ridge north-east of the gully and right away on to Mount Biggenden itself. The Mount Biggenden deposit consists of an irregular mass of magnetite, somewhat semicircular in shape, bounded on the north by the slates and on the south by the limestone."†

Limestones, conglomerates, and slates form the country-rock of the Mount Hastings Gold Mine, which is situated on the south side of Biggenden Creek, about two miles south-east of the Mount Biggenden Mine.‡

Gebangle, six miles north-north-west of Mount Shamrock, is situated in a country-rock consisting chiefly of stratified mud-rocks and siliceous slates, having a

\* Report by W. H. Rands on the Goldfields of Raglan, Calliope, &c. Brisbane: by Authority: 1885, p. 10.

† Report by W. H. Rands on Mount Biggenden Bismuth Mine, &c. Brisbane: by Authority: 1890.

‡ *Loc. cit.*, p. 3.

general dip of 50° to N. 15° E.\* The stratified rocks of Mount Biggenden, Mount Hastings, and Gebangle probably belong to the Gympie Beds, although there is no palæontological evidence nearer than Yarrol in support of this view.

The Mount Shamrock Gold, Silver, and Bismuth Mines, near the junction of Didcot and Chowey Creeks, are situated in a series of massive slates, hardened siliceous and felspathic sandstones, quartzites and conglomerates, traversed by igneous dykes. These stratified rocks have undergone sufficient metamorphism to render it difficult to distinguish the direction of either their dip or strike.† They probably belong to the Gympie Beds.

Between Eidsvold Township and Lochaber Station, "about a mile from Lochaber, one passes on to fine-grained sandstones, quartzites and slates, which are dipping 20° to the S. I should refer this formation, on lithological grounds, to the Devonian, which covers so large an area of this district; the same beds are met with along the road from Mount Perry to Eidsvold, where occasional beds of limestone occur."‡ The Lochaber rocks, as well as those between Mount Perry and Eidsvold, are now classed with the Gympie Beds.

The country-rock of the Cania Gold Field "consists of alternating layers of sandstone, slates, and limestones. The latter are of a pisolitic structure, and are in parts fossiliferous. I obtained, after a long search, a few specimens from a bed of limestone about 3 miles up the Three-moon Creek from the diggings. They were not, however, in a very good state of preservation. . . . In the creek just opposite to the township, the formation is dipping 30° to E. 15° S." At Kariboe Creek, on Kroombit Diggings, west of Cania, similar strata have also yielded some fossils. The whole are referred to the Gympie Beds. The fossils from Cania and Kariboe Creek, as determined by my Colleague, are:—

- Spirifera bicarinata*, Eth. fil.
- Martinia ? productoides*, Eth. fil.
- Martiniopsis ? subradiata*, var. *Morrisii*, Eth. fil.
- Athyris ambigua*, J. de C. Sby.
- „ *Randsi*, Eth. fil.
- Rhynchonella*, *sp. ind.*
- Orthis resupinata*, Martin.
- Productus brachythærus*, G. Sby.
- „ *semireticulatus*, Martin ?
- Lingula mytiloides*, J. Sby. ?
- Modiomorpha ? Daintreei*, Eth. fil.
- Goniatites*, *sp. ind.*, Pl. 15, figs. 14, 15.

In addition to the above Mr. Rands mentions the occurrence of corals.

The country-rock of the Raglan Gold Field (south of the mouth of the Fitzroy) consists chiefly of argillaceous and siliceous slates and hardened sandstones or quartzites. These beds strike north and south, and are on the whole nearly vertical, although at times they have a slight dip to the west. Their strike is from north to south. At Mount Holly a thick bed of conglomerate occurs. About a mile to the east of the Reserve is a bed of blue encrinital and coralline limestone dipping at a high angle to the west. This limestone is full of encrinite remains. Another bed of limestone two miles to the east runs

\* *Loc. cit.*, p. 4.

† Report by W. H. Rands on the Gold and Silver Deposits in the Neighbourhood of Mount Shamrock. Brisbane: by Authority: 1886.

‡ Report by W. H. Rands on the Eidsvold Gold Field. Brisbane: by Authority: 1887.

almost at right angles to the Mount Holly bed. At its western extremity for two or three miles it is full of encrinite stems. It is intersected by a north-westerly dyke of porphyry.

From a limestone on a hill near Langmorn, and about six miles to the south-west of the above, Mr. Rands obtained some specimens of Pelecypods. A similar limestone forms what are known as the Bald Hills. Several auriferous reefs and a copper lode occur among the slates of this neighbourhood.\*

In addition to the fossils collected by Mr. Rands, the late Mr. James Smith made a considerable collection from the Raglan and Langmorn Limestones. Mr. Smith identified the limestones, without hesitation, with those of Dalma and Lilymere near Rockhampton, and the slates in connection with the Raglan and Langmorn Limestones with the slates of the Rockhampton District. Mr. Smith obtained from a deposit of stalagma at Langmorn, which there, as at Dalma, represents caves from which the surrounding limestone has been denuded, a large bone which is as yet undetermined. I have no difficulty in classing the Raglan† and Langmorn Beds with the Gympie Beds. They have yielded the following fossils as determined by Mr. Etheridge:—*Favosites*, *sp. ind.*; *Cyathophyllum*, *sp. ind.*, Pl. 7, fig. 1; and *Myriolites*? *queenslandensis*, Eth. fl.‡

A bed of marble, probably the equivalent of some of the limestone beds at Langmorn and Raglan, crosses the Calliope River about a mile below Carrara Station. It "forms a bar across the river in a north-north-westerly direction, and has been quarried and shipped in small schooners which at high tide can come up the river as far as this bar. This marble would be valuable for statuary purposes. At the crossing [of the Rockhampton and Gladstone road] is a dyke of porphyry, with small blebs of quartz, running parallel with the marble. This has partially decomposed into kaolin.

"The limestone is met with every here and there on either side of Brennan's Flat, on Sheep Station Hill, Ten Men's Gully, Gordon's Gully, and other places [on the Calliope Gold Field]; then going in the same direction, and crossing the watershed on either side of New Zealand Gully and on to the Boyne River at the settlement called Marblestone, where it occupies nearly the whole area between Raggote Creek and the river. At Marblestone it is in places a greyish-white marble, which will take a good polish. It again occurs on the south side of the Boyne. I was unable to detect any organic remains in these limestones; they have become very crystalline, and in all probability any fossils they may have contained have been destroyed during their change."§ Several auriferous reefs occur in slates and schists associated with the limestones.

At Kooingal extensive deposits of limestone have been successfully exploited for fossils by the late Mr. James Smith. The fossils prove the limestones to be approximately of the age of the Gympie Beds. So far as they have been determined by my Colleague they are as follow:—

*Monticulipora*, *sp. ind.*, Pl. 38, figs. 1, 2.

*Stenopora*, *sp. ind.*, Pl. 6, figs. 14, 15.

Crinoid stems.

*Fenestella*, *sp. ind.*

*Aviculopecten multiradiatus*, Eth.

\* Report by W. H. Rands on the Goldfields of Raglan, &c. Brisbane: by Authority: 1885.

† I regret to say I cannot concur with my Colleague in the classification of the Raglan Limestone with the Gympie Beds. The fossils that I have seen from Raglan, including in a later collection made by Mr. Smith *Cystiphyllum*, remind me far more of those of the Burdekin Beds. I have never seen *Favosites* from the Gympie Beds, and certainly not *Cystiphyllum*; neither have I observed any trace of *Myriolites* from Raglan. (*R.E. junr.*)

‡ Occurs also in the Lilymere and Dalma Limestones, near Rockhampton (*vide* Smith).

§ Report by W. H. Rands on the Gold Fields of Raglan, Calliope, &c., 1885, p. 3.

From the neighbourhood of Rockhampton, chiefly owing to the labours of Mr. C. W. de Vis and the late Mr. James Smith, we have obtained a rich collection of fossils, which not only enables us to place the strata of that district on the horizon of the Gympie Beds but also to add considerably to the Gympie list.

After collecting from the limestones at Dalma and Lilymere, Mr. Smith came to the conclusion that in the Rockhampton District the greater part of the fossiliferous beds, including the "Annelid" beds of Thozet's Creek, the Trilobite beds of Crow's Nest, the Encrinite and Fenestella bearing beds of Fenestella Hill, the Encrinite and Productus Beds of Encrinite Creek, near Mount Morgan, and the Fenestella and Productus bearing beds of Lake's Creek and the Training Wall Quarries, lie unconformably on what he calls the "Central Queensland Shales," of which the strata seen in the Rockhampton quarry may be taken as the type, and of which the Lilymere and Dalma limestones form a part. He remarked on "the extreme paucity of fossils in the old shales, their different composition, the high angles at which they lie, their uniform dip and strike, and their thick accumulations; whereas the fossiliferous rocks are generally thin, lie at all low angles, and dip and strike in every direction." As has already been noted, Mr. Smith identified the Dalma and Lilymere Limestones with those of Raglan and Langmorn. In the latter district he admitted that the limestone beds are *interstratified with* and conformable to the "Central Queensland Shales" (an observation entirely in accord with Mr. Rands' description of the Raglan District), so that the unconformability at Rockhampton, if it exists, must be a local and unimportant one.

In the above remarks it must be noted that the fossiliferous beds of Stewart's Creek, Wycarbah, Rosewood, and Stanwell (in part) are not included.

The Rockhampton District has not yet been geologically mapped, and I have only Mr. Smith's notes and a few hasty traverses of my own to refer to.

An immense series of limestone beds is developed on both sides of the Fitzroy River, from Rockhampton to near Yaamba. The limestone beds crop out over a tract of country about ten miles in width, as measured across the strike, which is almost always to the north-west. On the south-western side are the limestones of Mount Siluria, west of the Lower Gracemere Lagoon, and Lion Creek. These limestones, so far as I know, have yielded no fossils. A peculiar structure brought out by the weathering of the Mount Siluria Limestone, and supposed at one time to point to a coralline origin, proved on microscopic examination to be merely oolitic or concretionary. Some hard, greenish, fine-grained siliceous and calcareous sandstones, associated with the limestone, yield, however, abundant encrinite stems. This limestone and the associated strata dip at high angles to the south-west. Limestones in the same line of strike are seen crossing Limestone Creek, which falls into the right bank of the Fitzroy, from three to four miles above its junction with Black Gin Creek. Limestone beds are also seen striking to the north-west from the south end of Lilymere Lagoon. The strike of these beds, if produced to the south-east, would pass through the Murray Lagoon, about a mile north-east of which is the Rockhampton Quarry, in beds of hardened sandstones and shales, dipping to N.E. at 70°. These strata have yielded some undistinguishable plant-impressions. Between the quarry and Murray Lagoon are the comparatively soft grey sandstones and shales which form the gentle elevation known as the Athelstane Range. The "Rocks" above the Suspension Bridge consist of hardened or jasperised slates, &c., which dip N.N.W. at 30°. On the left bank of the Fitzroy from nearly opposite the mouth of Lion Creek, limestone beds are traceable almost continuously north-westward for at least a mile or two north of the Long Island in the Fitzroy. Intercalated with the limestones near Ramsay's Creek, Belmore Creek, and the Long Island, are hardened slaty rocks and hardened



fine-grained quartzose greywackes. On the left bank of the river, opposite the north end of the Long Island, the strata dip at  $45^{\circ}$  to N.E., while opposite the south end of the Island they dip at  $70^{\circ}$  to S.W. In the whole of the region above described the frequent reversals of dip probably bring about frequent repetitions, at the surface, of the various limestone and other beds.

In what is no doubt a prolongation of the Dalma Limestones, near Mount Etna, about four miles east of Yaamba, are the famous Olsen's and Johansen's Caves, which are alluded to in another place. The Dalma Limestone contains masses of stalagma, with vertebrate remains, attesting the former existence of caverns in the limestone.

East of the Fitzroy, the low hills at the foot of Berserker Range show sandstones and shales dipping to the south-west; so that there is probably a synclinal trough between these hills and the Rockhampton quarry. In Thozet's Creek, which falls into the left bank of the Fitzroy, below the reserve for pasturage, hard flinty fine-grained siliceous sandstone dips at an angle of  $30^{\circ}$  to W. This sandstone is a mass of infilled tubes, believed by many to be made by Annelids.\* Fragments of a similar rock are found lying loose on the Athelstane Range, on the ridges at Gracemere, and at Kabra. I should be inclined to think that the "Annelid Bed" dips beneath the limestone seen on Limestone Creek to the north-west, although Mr. Smith regarded it as lying unconformably on the latter.

In Lake's Creek and the "Training Wall Quarries," on the left bank of the Fitzroy below the mouth of Lake's Creek, are fine-grained dark-greenish sandstones full of *Fenestella*, *Protoretetpora*, Brachiopods, &c., probably slightly below the horizon of the Thozet's Creek Beds. The quarries have recently yielded to the late Mr. James Smith specimens of *Lepidodendron*, probably *L. australe*, and *Calamites*, *sp. ind.* In the Cawarral District the strata graduate from serpentinous slates and schists to serpentine (auriferous). The originally sedimentary origin of the Cawarral Serpentine, however metamorphosed, is evidenced by the occurrence of a specimen, collected by Mr. Smith, and now in the Geological Survey Collection, containing the impression of a small fossil, which my Colleague says "may be either a perforate *Spirifera* or *Athyris*."

Grits and slates are seen in the Berserker Ranges, and on the road from Rockhampton to Cawarral. These beds may be beneath the horizon of the Lake's Creek Beds.

At Taranganba, south of Yeppoon, is a considerable mass of flaggy quartzite beds, striking for the most part north and south, and on the whole vertical, although sometimes contorted. The quartzites invariably contain a good deal of fine pyrites, in which traces of gold are obtainable. The quartzites are traversed by many leaders, reefs, and lodes, which are in some degree auriferous. They are also intersected by dykes of acidic felstone.†

North Keppel Island, in Keppel Bay, opposite Yeppoon, is composed of slates and greywackes dipping at high angles to the north-west, and intersected by dolerite dykes.

South-west of Rockhampton, Stony Creek, near Stanwell, brings down boulders of pale-green fine-grained hardened siliceous sandstone, rich in the remains of Trilobites, Encrinites, and Brachiopods. The strata from which these boulders have been derived are seen *in situ* at Crow's Nest, near Mount Morgan.

Neerkol Creek, near Stanwell, has also yielded to Mr. Smith a large collection of fossils of the genera *Spirifera*, *Productus*, *Strophomena*, *Orthis*, *Aviculopecten*, and *Fenestella*.

\* See my Colleague's remarks in the Monograph of the Silurian Fossils of Girvan, Fasc. 3, p. 304. Mr. Etheridge doubts the Annelid origin of the Thozet's Creek burrows.

† See Report by R. L. Jack on Taranganba Gold Mine. Brisbane: by Authority: 1889.

On the opposite side of the range (which is capped by Desert Sandstone), similar strata at Fenestella Hill and Encrinite Creek, near Mount Morgan, on the Dee Fall, have yielded to Mr. Smith a profusion of similar fossils.

The locality of the Don River from which the Rev. W. B. Clarke obtained the fossils described in 1872 by Mr. R. Etheridge, F.R.S.,\* is somewhat doubtful, but as the Don River near Bowen cannot possibly be the locality in question, it is probable that the Don River referred to is that which falls into the Dee in Lat. 24° S.

Mr. De Vis' fossils from the "Rockhampton District" are said by Mr. De Vis to come "from the Agricultural Reserve—from the Fitzroy at Laurel Bank, about ten miles from Rockhampton, westwards to the Nine-mile Lagoon; thence to the Corporation Quarry, Athelstane Range, and to the northern outcrop (at foot of Berserker's) of the synclinal beneath the township and bed of river." The district thus described is probably altogether fairly within the Rockhampton Beds, as the term is used by us.

The following are lists of the fossils from the various localities in the Rockhampton District, as determined by my Colleague. They sufficiently justify our uniting the Rockhampton Beds with the Gympie Formation.

#### (1) LILYMERE LIMESTONE.

<i>Myriolites? queenslandensis</i> , Eth. fil.	<i>Mourlonia Strzeleckiana</i> , Mor.
<i>Retzia? lilymerensis</i> , Eth. fil.	

#### (2) LAKE'S CREEK AND TRAINING WALL QUARRIES.

<i>Calamites</i> , sp. ind.	<i>Productus cora</i> , D'Orb.
<i>Lepidodendron australe</i> , McCoy?	„ <i>subquadratus</i> , Mor.
<i>Fenestella fossula</i> , Lonsd.	<i>Goniatis planorbiformis</i> , Eth. fil.
<i>Martinia? productoides</i> , Eth. fil.	„ sp. ind., Pl. 15, figs. 14, 15.

#### (3) BLACKFELLOW'S DIGGINGS.

<i>Fenestella fossula</i> , Lonsd.	<i>Protoretapora ampla</i> , Lonsd.
<i>Polypora? Smithii</i> , Eth. fil.	

#### (4) STONY CREEK (STANWELL) AND CROW'S NEST.

<i>Poteriocrinus? Smithii</i> , Eth. fil.	<i>Orthis australis</i> , McCoy.
Arms of crinoid, Pl. 7, fig. 7.	<i>Productus cora</i> , D'Orb.
„ Pl. 7, fig. 8.	„ <i>brachythærus</i> , G. Sby.
Crinoid stems.	„ <i>undatus</i> , DeFrance.
<i>Granatocrinus? Wachsmuthii</i> , Eth. fil.	„ <i>semireticulatus</i> , Martin?
<i>Phillipsia Woodwardi</i> , Eth. fil.	„ sp. ind. (b), Pl. 12, fig. 15.
„ ? sp. ind.	„ sp. ind. (c), Pl. 13, fig. 4.
<i>Griffithides seminifera</i> , Phill.	<i>Chonetes cracouensis</i> , Eth.
<i>Rhombopora? laza</i> , Eth.	„ sp. ind. (a), Pl. 13, fig. 10; Pl. 37, figs. 21, 22.
<i>Spirifera vespertilio</i> , G. B. Sby.	„ sp. ind. (b), Pl. 13, figs. 7, 8, 13.
„ <i>trigonalis</i> , var. <i>crassa</i> , De Kon.	<i>Aviculopecten Laurenti</i> , Eth. fil.
„ <i>bicarinata</i> , Eth. fil.	<i>Loxonema</i> , sp.
<i>Martinia? productoides</i> , Eth. fil.	<i>Euomphalus</i> , sp.
<i>Athyris Roysii</i> , Leveillé.	<i>Platyschisma oculus</i> , J. de C. Sby.
<i>Rhynchonella pleurodon</i> , Phill.	<i>Bellerophon stanwellensis</i> , Eth. fil.
<i>Orthis resupinata</i> , Martin.	

\* Quart. Journ. Geol. Soc. Lond., xxviii., p. 333 et seq.

## (5) ENCRINITE CREEK.

*Poteriocrinus crassus*, Miller?| *Productus brachythærus*, G. Sby.

## (6) FENESTELLA HILL.

*Poteriocrinus crassus*, Miller?| *Polypora? Smithii*, Eth. fil.*Fenestella internata*, Lonsd.| *Productus brachythærus*, G. Sby.

## (7) ATHELSTANE RANGE.

Crinoid stems.

| *Chonetes cracowensis*, Eth.*Orthis rescupinata*, Martin.| „ *sp. ind. (b)*, Pl. 13, figs. 7, 8, 13.

## (8) DON RIVER.\*

*Phillipsia dubia*, Eth.| *Naticopsis? harpaformis*, Eth.*Spirifera, sp. ind. (a)*, Pl. 9, fig. 12.| *Murchisonia carinata*, Eth.*Productus longispinus*, J. Sby.?

## (9) "ROCKHAMPTON DISTRICT" (DE VIS).

*Lasiocladia? Hindei*, Eth. fil.| *Productus, sp. ind. (d.)*, Pl. 40, fig. 4.*Cladochonus tenuicollis*, McCoy.| *Aviculopecten Laurenti*, Eth. fil.*Zaphrentis profunda*, Eth. fil.| *Pterinopecten Devisii*, Eth. fil.*Actinocrinus, sp. ind.*, Pl. 7, fig. 9.| *Mytilops? corrugata*, Eth. fil.

Cup of crinoid, Pl. 44, fig. 7.

| *Parallelodon costellata*, McCoy.

Impressions of crinoid calix, Pl. 44, fig. 8.

| *Nucula, sp. ind.*, Pl. 40, fig. 10.*Mesoblastus? australis*, Eth. fil.| *Platyschisma rotundata*, Eth.*Tricælocrinus? Carpenteri*, Eth. fil.| *Yvania Konincki*, Eth. fil.*Archæocidaris, sp.*| *Luciella? Grayæ*, Eth. fil.*Griffithides seminifera*, Phill.| *Murchisonia, sp. a.**Glauconome, sp. ind.*, Pl. 44, fig. 11.| „ *sp. b.**Dielaema sacculus*, var. *hastata*, J. de C.| „ *sp. c.*

Sow.

| *Bucania textilis*, De Kon.„ ? *sp. ind.*, Pl. 40, figs. 1, 2.| *Porcellia Pearsi*, Eth. fil.*Spirifera, sp. ind. (a.)*, Pl. 9, fig. 12.| *Nautilus, sp.*„ *trigonalis*, Martin.| „ ? *ammonitiformis*, Eth. fil.„ *pinguis*, J. Sby.| *Orthoceras, sp.**Reticularia lineata*, Martin?| *Gyroceras dubius*, Eth. fil.*Orthis australis*, McCoy.| *Goniatites planorbiformis*, Eth. fil.*Strophomena rhomboidalis*, var. *analogæ*,| *Deltodus? australis*, Eth. fil.

Phill.

The Rockhampton District as a whole has afforded the following fossils:—

*Calamites, sp. ind.*

Arms of crinoid, Pl. 7, fig. 7.

*Lepidodendron australe*, McCoy?

| „ „ Pl. 7, fig. 8.

*Lasiocladia? Hindei*, Eth. fil.

| Stems of crinoid.

*Cladochonus tenuicollis*, McCoy.

| Impressions of crinoid calix, Pl. 44, fig. 8.

*Zaphrentis profunda*, Eth. fil.| *Poteriocrinus? Smithii*, Eth. fil.*Actinocrinus, sp. ind.*, Pl. 7, fig. 9.| „ *crassus*, Miller?

Cup of crinoid, Pl. 44, fig. 7.

| *Mesoblastus? australis*, Eth. fil.

\* See remarks on p. 92.

## ROCKHAMPTON DISTRICT FOSSILS—continued.

- Granatocrinus ? Wachsmuthii*, Eth. fil.  
*Tricælocrinus ? Carpenteri*, Eth. fil.  
*Archæocidaris*, sp.  
*Phillipsia dubia*, Eth.  
     " *Woodwardi*, Eth. fil.  
     " ? *sp. ind.*  
*Griffithides seminifera*, Phill.  
*Fenestella fossula*, Lonsd.  
     " *internata*, Lonsd.  
     " *sp. ind.*  
*Polypora ? Smithii*, Eth. fil.  
*Protoretepora ampla*, Lonsd.  
*Glauconome*, sp. ind., Pl. 44, fig. 11.  
*Rhombopora ? laxa*, Eth.  
*Myriolithes ? queenslandensis*, Eth. fil.  
*Dielasma sacculus*, var. *hastata*, J. de C. Sby.  
*Dielasma ? sp. ind.*, Pl. 40, figs. 1, 2.  
*Spirifera*, sp. ind. (a.), Pl. 9, fig. 12.  
     " *vespertilio*, G. B. Sby.  
     " *trigonalis*, Martin.  
     " *trigonalis*, var. *crassa*, De Kon.  
     " *pinguis*, J. Sby.  
     " *bicarinata*, Eth. fil.  
*Reticularia lineata*, Martin ?  
*Martinia ? productoides*, Eth. fil.  
*Retzia ? lilymerensis*, Eth. fil.  
*Athyris Roysii*, Leveillé.  
*Rhynchonella pleurodon*, Phill.  
*Orthis resupinata*, Martin.  
     " *australis*, McCoy.  
*Strophomena rhomboidalis*, var. *analoga*, Phill.  
*Productus cora*, D'Orb.  
     " *brachythærus*, G. Sby.  
     " *subquadratus*, Morris.  
     " *undatus*, Defrance.
- Productus semireticulatus*, Martin ?  
     " *longispinus*, J. Sby.  
     " *sp. ind. (b.)*, Pl. 12, fig. 15.  
     " *sp. ind. (c.)*, Pl. 13, fig. 4.  
     " *sp. ind. (d.)*, Pl. 40, fig. 4.  
*Chonetes cracowensis*, Eth.  
     " *sp. ind. (a.)*, Pl. 13, fig. 10;  
         Pl. 37, figs. 21, 22.  
     " *sp. ind. (b.)*, Pl. 13, figs. 7, 8, 13.  
*Aviculopecten Laurenti*, Eth. fil.  
*Pterinopecten Devisii*, Eth. fil.  
*Mytilops ? corrugata*, Eth. fil.  
*Parallelodon costellata*, McCoy.  
*Nucula*, sp. ind., Pl. 40, fig. 10.  
*Naticopsis ? harpæformis*, Eth.  
*Loxonema*, sp.  
*Euomphalus*, sp.  
*Platyschisma oculus*, J. de C. Sby.  
     " *rotundata*, Eth.  
*Mourlonia Strzeleckiana*, Mor.  
*Yvania Konincki*, Eth. fil.  
*Luciella ? Grayæ*, Eth. fil.  
*Murchisonia carinata*, Eth.  
     " *sp. a.*  
     " *sp. b.*  
     " *sp. c.*  
*Bellerophon stanvellensis*, Eth. fil.  
*Bucania textilis*, De Kon.  
*Porcellia Pearsi*, Eth. fil.  
*Nautilus*, sp.  
     " ? *ammonitiformis*, Eth. fil.  
*Orthoceras*, sp.  
*Gyroceras dubius*, Eth. fil.  
*Goniatites planorbiformis*, Eth. fil.  
     " *sp. ind.*, Pl. 15, figs. 14, 15.  
*Deltodus ? australis*, Eth. fil.

Of the above, *Fenestella fossula*, *Polypora ? Smithii*, *Protoretepora ampla*, *Rhombopora ? laxa*, *Spirifera vespertilio*, *Spirifera trigonalis*, *Strophomena rhomboidalis*, var. *analoga*, *Productus cora*, and *Orthoceras*, sp., are common to the Gympie Beds of the type district. *Spirifera bicarinata*, *Martinia ? productoides*, *Orthis resupinata*, *Productus brachythærus*, *P. semireticulatus*, and *Goniatites*, sp. ind. (Pl. 15, figs. 14, 15), are common to the Cania Beds. *Productus brachythærus* and *Mourlonia Strzeleckiana* are common to the Yarrol Beds. *Myriolithes ? queenslandensis* is common to the Langmorn Beds. *Productus subquadratus* is common to the Yatton Beds.

A scrubby hilltop, three miles south-west of the Yatton Gold Field Township (west of the mouth of the Styx River), is capped by a bed of grey limestone which dips

S.S.E. at 45°, but owing to the thickness of the scrub and other difficulties the relation of the limestone to other rocks in the neighbourhood is not ascertainable. This limestone has yielded a large number of fossils in good preservation, amongst which my Colleague has recognised :—

*Spirifera lata*, McCoy.

„ *Stokesii* (common to Gympie).

*Martinia Darwinii*.

*Productus subquadratus* (common to Rockhampton Beds).

„ *sp. ind. (f.)*, Pl. 44, fig. 13.

*Aviculopecten limæformis* (? common to Gympie Beds).

*Eurydesma, sp. ind.*

Between Yatton and St. Lawrence, in ascending the coast range from Waverley Station to Killarney by the old road from St. Lawrence to Peak Downs, a great thickness of coarse green conglomerate is exposed. The sandy matrix and the boulders are of similar material—namely, felsite and porphyrite—so that the conglomerate does not weather in the customary manner of conglomerates. The exposed surfaces, on the contrary, show the pebbles shorn off down to the same level as the matrix, so that it is only on a fresh fracture that the true character of the rock can be seen. In this respect the conglomerate resembles the Gympie conglomerate. It probably belongs to the same formation as the Yatton Limestone.

Mr. Smith found his “Central Queensland Shales” (Rockhampton Beds) unconformably overlaid by the strata of the Styx River Coal Field (Burrum Beds) on Barrack Creek, a tributary of the Styx. Between the Styx Coal Field and the Bald Hills he observed among the Central Queensland Shales a thick bed of encrinital limestone, striking north-north-west, and very probably a continuation of the Dalma and Rockhampton Limestones.

I have little hesitation in mapping the greater part of the district lying between the Burrum Coal Field on the east, and the Dawson River Coal Field on the west, from Gayndah on the south to Broadsound on the north, as of the age of the Gympie Beds. This area, it may be mentioned, was mapped as Devonian in the Geological Map of Queensland issued in 1886. In some districts within this large area the Gympie Beds are overlaid by Basalt, Desert Sandstone, the Burrum Beds, and by the Middle and perhaps the Upper Series of the Bowen River Coal Field, while on the other hand granite and other plutonic and intrusive rocks and masses of serpentine occupy portions of the area.

The late Mr. Daintree observed, at Mount Wyatt Diggings, certain slates and shales containing *Chonetes sarcinulata*, an *Orthis* allied to *O. rustica*, *Receptaculites*, and *Leptæna*, as determined by Sir F. McCoy. These rocks were unconformably overlaid by beds, probably of the “Star” Series, containing *Lepidodendron*. On the strength of the fossils the strata first alluded to were assumed to be of Upper Silurian age. The assumption was based on a single distinctly specifically determined Brachiopod, *Chonetes sarcinulata*, now known to range upward into Devonian times, an *Orthis*, which might be allied to an Upper Silurian species, without being itself of that age—the genus ranging all through the Silurian, Devonian, and Carboniferous—a *Receptaculites*\* and a *Leptæna* (Silurian and Devonian) not specifically determined. I have not been able to identify the locality referred to by Mr. Daintree, but as I observed both the Star Beds and the Gympie Beds in the neighbourhood, I think it probable that the *Chonetes*, &c., beds belong to the latter.

\* Every effort has been made, both in London and Brisbane, to trace this fossil but without success. (*R.E. junr.*)

Treating the Gympie Beds from Lat. 21° southward as a whole, and including all the fossiliferous rocks of the Rockhampton District, Kooingal, Cania, Yatton, Yarrol, Raglan, and Langmorn, we have a very extensive list of fossils. By reference to the lists given on pages 43 and 92-94, several points of interest may be noted.

It will be seen, in the first place, that there is a very decided hiatus between the life of the Gympie Formation and that of the Devonian, not a single species being common to the two formations, and only three genera of Actinozoa, viz., *Favosites*, *Pachypora*, and *Cyathophyllum*, and two of Brachiopoda, viz., *Spirifera* and *Rhynchonella*.

Turning to the other members of the Permo-Carboniferous System, we find that all the genera of Plants, viz., *Calamites*, *Lepidodendron*, and *Cordaites*, known in the Gympie Formation, are also present in the Star Formation. Among Crinoids, *Actinocrinus*, and among Crustaceans, *Phillipsia*, are common to both. Among Polyzoa, *Fenestella* is present in both. Lastly, the two formations have no less than nine genera of Mollusca in common—viz., *Spirifera*, *Reticularia*, *Retzia*, *Rhynchonella*, *Orthis*, *Strophomena*, *Chonetes*, *Naticopsis*, and *Porcellia*. None of the genera of plants found in the Gympie Formation are met with either in the Middle or Upper Bowen Formations. Of Actinozoa, *Stenopora* is the only genus common to the Gympie and Middle Bowen. Of Polyzoa, *Fenestella* and *Protoretetpora* are genera common to the Gympie and Middle Bowen. Of Mollusca, fourteen genera are common to the Gympie and Middle Bowen—viz., *Dielasma*, *Spirifera*, *Martinopsis*, *Productus*, *Chonetes*, *Aviculopecten*, *Modiomorpha*, *Astartella*, *Chænomya*, *Mourlonia*, *Bellerophon*, *Porcellia*, *Orthoceras*, and *Goniatites*. *Productus* and *Goniatites* are genera common to the Gympie and Upper Bowen.

No less than ninety-five species are peculiar to the Gympie Beds. Twelve are common to the Star Beds, seventeen to the Middle Series of the Bowen River Coal Field, and two to the Upper Series. It would appear from this that the Gympie Beds have most in common with the Middle Bowen River Beds, and nearly as much with the Star Beds. It must be recollected, however, that the Bowen River Beds and the Star Beds, especially the latter, have as yet been but imperfectly collected from.

It will be remembered that *Lepidodendron* has never yet been traced upward into the Bowen River Beds, although it is a characteristic plant of the Star Beds. It has, however, been found in the Gympie Beds in the Training Wall Quarries at Rockhampton, and naturally forms a strong link connecting the Star and Gympie Beds. The abundance (in individuals) of Eocrinoids and Trilobites is another point which the Gympie and Star Beds have in common. Several species of *Spirifera*, *Rhynchonella*, *Orthis*, *Strophomena*, and *Chonetes*, and some of Gasteropoda, are also common to the Star and Gympie Beds.

On the other hand, *Fenestella* is very abundant both in the Gympie Beds and the Middle Bowen River Beds. Three species of *Spirifera*, one of *Reticularia*, one of *Martinia*, one of *Orthis*, one of *Strophomena*, three of *Productus*, one of *Chonetes*, one of *Aviculopecten*, one of *Chænomya*, one of *Platyschisma*, one of *Bellerophon*, one of *Porcellia*, and one of *Orthoceras* are common to the Gympie and Middle Bowen Beds.

In the face of the greater number of species common to the Gympie and Middle Bowen Beds than are common to the Gympie and Star Beds, it is not without some misgivings that I come to the conclusion that the Gympie Beds come nearer to the Star than to the Middle Bowen Beds. I was indeed till recently inclined to favour the idea that the auriferous Gympie Beds were only the coal-bearing Middle Bowen Beds somewhat metamorphosed, and the presence of beds of graphite among the Gympie rocks lent colour to this view. But now, on the completion of my Colleague's work, it strikes me forcibly that if the two series were identical there could not be such a large number

of species in the one which are not represented in the other. The Gympie Beds contain ninety-five species peculiar to themselves, and the Middle Bowen Series thirty-four species peculiar to itself. I am quite open to conviction should future evidence turn up to prove the identity of the Gympie Beds either with the Star or Middle Bowen Beds; but in the meantime I think it safer to keep the Gympie Beds apart and to assign to them a position beneath the Star Beds, for the reasons already stated.

I am not able to identify the Gympie Formation with anything in New South Wales or Victoria, unless mere lithological resemblance can be taken as a guide; but, considering how near to the southern border of Queensland the Gympie Formation has been traced, it is more than likely that some of the New South Wales sedimentary rocks, at present doubtfully referred to Silurian and Devonian, may yet prove to be on the Gympie horizon.\*

The Star Beds have undergone, so far as I have observed, no very great degree of metamorphism. Portions of them, such as the Drummond Beds, may be said to have undergone no metamorphism at all. The Gympie Beds, on the other hand, are at least in places considerably metamorphosed.

The Lower Series of the Bowen River Coal Field, which is believed to be newer than the Gympie Beds, has suffered in the Mackay District a very considerable amount of metamorphism.

#### MINES IN CONNECTION WITH THE GYMPIE FORMATION OUTSIDE OF THE TYPE DISTRICT.

##### KILKIVAN AND BLACK SNAKE.

"Most of the work at Kilkivan has been the driving of tunnels in a sheet of white porphyry, which occurs in the face of a range running north and south. The porphyry varies greatly in thickness. There are no defined reefs at all in the porphyry, but only minute veins of quartz with oxides of iron and manganese. Where the manganese dioxide occurs the veins are the richest in gold. In some parts of the porphyry these veins are very numerous, and the veins are very patchy. Where these patches occur, however, the whole of the mass will pay to crush. No large quantity of stone can be obtained. Two men who have been working in the Long Tunnel P.C., which is considered the best claim in the porphyry, after six months' work, have just had a crushing of 8½ tons for 2½ oz. of smelted gold. The cost of carting and crushing alone was £3 per ton.

"The country around Kilkivan consists entirely of metamorphic rocks, such as serpentine, hornblendic and micaceous schists. All the reefs found in this district occur in these rocks. From the Rise and Shine Reef very good specimens of gold in the quartz were obtained in the upper part. Lower down the stone changes to a mundic consisting greatly of zinc-blende with some iron pyrites and a little galena.

"The country between Kilkivan and the Black Snake and Mount Coora is entirely of schists—chiefly hornblendic—and mica-schists, which have a steep inclination to the north-west.

"The gold-bearing reefs of the Black Snake district occur in a micaceous porphyrite. This rock consists of a felsitic base with porphyritic crystals of oligoclase

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\* I suspect that the Gympie Beds will prove to be identical with the New South Wales strata termed by me "Carboniferous"—formerly known as "Lower Carboniferous"—so largely represented in the Port Stephens District. Possibly the Star Beds will also be identical. (*R.E. junr.*)

felspar and mica, some pyrites, and here and there viridite and chlorite from the decomposition of some of the original constituents of the rock. This rock occupies a small area of about 3 square miles. The reefs generally have a north-west bearing and are perpendicular, or have a slight underlie to the east or south-east. The ores from these reefs are complex; in the Mariner's Reef, for instance, at a small depth the ore consists of iron, copper, arsenical pyrites, silver-lead ore (galena), and a small amount of sulphide of antimony. The gold in this ore was equal to a little over 1 oz. per ton, the silver to about 25 oz. per ton. Copper, as carbonate or sulphide, is met with, sometimes sufficiently rich to smelt; 50 tons from the Rose, Shamrock, and Thistle Reef were sold to the Mount Coora Copper Mining Company.

"Outside this area of porphyrite, northward towards Mount Coora, are altered rocks consisting of serpentine and of an altered volcanic rock, probably an altered dolerite. The whole area was most probably of the same volcanic rocks, parts of which have undergone a greater change. It is in these rocks that the Mount Coora and Mount Clara copper lodes occur.

"The Black Snake is now almost entirely deserted. This state of affairs is due, in my opinion, not so much to the poverty of the reefs, as to the fact that the land, having become private property, is closed to general enterprise. This field has, moreover, got a bad name owing to the investment of a large amount of capital in erecting furnaces and extravagant crushing plants instead of in the mines themselves."\*

In his "Report on the Geology and Mineral Resources of the Districts of Kilkivan and the Black Snake,"† Mr. Rands describes the Rise and Shine (which has given 2,700 oz. of gold from 1,336 tons of stone), Morning Star, Welcome, Perseverance, and New Year's Reefs at Kilkivan, and the Rose, Shamrock, and Thistle, Tableland, New Zealand, Black Snake, Homeward Bound, Mariner's, and Victoria Reefs at Black Snake. Of the Black Snake Reefs, Mr. Rands observes: "Judging from specimens of ore I saw, and also from assays of samples, there can be no doubt as to the high value of the ores in this district, and as the reefs generally are of a good average width, some of them, at any rate, should pay well to work. The ore would require special and expensive treatment to extract the gold and other metals of commercial value, and it would probably be found advisable to merely concentrate them on the field and send them elsewhere for treatment."

Important copper lodes occur in the Black Snake District at Mount Coora and Mount Clara and other localities, but are not now worked.

#### KILKIVAN MERCURY MINES AND MOUNT COORA COBALT MINE.

Mr. Rands reported as follows on the Queensland and Wolf Cinnabar Lodes at the end of 1886:

"The matrix of the lodes consists of quartz and calcite. Both lodes are looking well, showing cinnabar all through the stone.

"At the Queensland Lode the shaft is down 42 feet. The lode runs north and south. At the bottom of the shaft the lode is divided into two parts by a 'horse' of mudrock. On the eastern part of the wall is a small vein of quartz which is very rich in ore; next to this is about 80 ft. of quartz and calcite with ore throughout it, while on the hanging wall is another mass of quartz containing cinnabar. A little to the

\* W. B. Rands, *Report on the Geology and Mineral Resources of the Districts of Kilkivan and the Black Snake*, p. 24, 1886.

† *Geological Survey of Victoria*, 1886.



north of the shaft the lode takes a sharp bend to the west. The country is an altered conglomerate or agglomerate, probably of volcanic origin, as it is full of angular particles.

"On the Wolf Lode a level has been driven on the bank of the gully for 170 feet on the lode. The country for the first 100 feet or so consists of sandstone and shale dipping south-west at this point, and above them is a volcanic ash, much decomposed, and containing often large angular pebbles. The lode runs north-east, and averages about 1 foot in thickness. The matrix contains much more calcite than that of the Queensland Lode.

"A cross-cut lower down the gully cuts several lodes or veins. At 19 feet, one of 1 foot in thickness of calcite; at 55 feet, a lode of 1 foot 2 inches wide showing good ore; at 119 feet is a vein of calcite which appears to be dipping towards some leaders at 145 feet, which contains cinnabar; and at 200 feet the Wolf is cut 4 feet 2 inches wide, and contains a very good percentage of cinnabar.

"Very rich pieces of nearly pure cinnabar have been picked up in a gully on this claim, supposed to have come from a small vein a short distance from the Wolf Claim.

"So far as the work has at present gone the prospect for the future of these mines looks very encouraging."\*

Nothing is recorded of the output of the cinnabar mines. In 1877 the Warden reported that "considerable progress has been made by the Messrs. Hester at their cinnabar works. They have for some time past kept the machines at Gympie fully supplied with quicksilver. The quicksilver supplied by Hester Brothers is preferred by the amalgamators at Gympie to the best article of its kind imported." Very little progress has been made, although it was reported in 1886 that a company had been formed to work them.

Recently information has come to hand that a valuable deposit of stream cinnabar has been discovered.

Several cinnabar lodes occur in the district on the heads of Wide Bay Creek.

A cobalt lode occurs in a spur of Mount Coora, consisting of serpentine. The lode has been traced over half-a-mile north and south, and underlies to the west at about 50°. "At its outcrop the lode consists of 10 or 12 feet of a talcose casing, with cobalt ore throughout it next to the foot-wall; then 22 feet of cobalt ore with a brown siliceous matrix (this forms the chief ore-bearing portion of the lode); above this again, next to the hanging-wall, is a mineral similar to pimelite, consisting of silicates of magnesia and alumina with a little silicate of nickel. A tunnel, 80 feet in length, has been put in on the back of the lode, and from the end of the tunnel a cross-cut has been driven through the lode, which passed through 15 feet of the main portion or cobalt-bearing part of the lode, and then about 10 feet of the casing seen at the surface; beyond this another mass of cobalt ore occurs, the width of which has not yet been ascertained. The ore is that known as earthy cobalt, consisting of oxides of cobalt, manganese, iron, and a little copper.

"Assays have shown the average ore to contain about 6 per cent. of cobalt, which, according to last Sydney quotations, is worth about £13 10s. per ton. By hand-picking the ore it might be brought up to about 10 per cent., which would be worth £23 per ton. The extent of the lode, and the large body of ore it contains, makes this undoubtedly a very valuable and important discovery."†

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\* Report of the Department of Mines for 1886.

† W. H. Rands in Report of the Department of Mines for 1886.

## GAYNDAH GOLD FIELDS.

## MOUNT SHAMROCK.

This goldfield is a comparatively new field, and its output appears for the first time in 1877, as 3,348 oz. of gold from 3,151 tons of stone crushed. In the same year 5 tons of bismuth ore were exported.

Mount Shamrock is a low hill about 145 feet in height above the level of Didcot Creek, which runs at its foot on the eastern side. The hill consists almost entirely of a dark-coloured massive slate, which is intersected by dykes of porphyry. It was on the summit of this hill, close to where their shaft now is, that the prospectors first discovered the gold in a piece of iron-stained stone lying at the surface.

## MOUNT SHAMROCK PROSPECTING CLAIM.

In a shaft 30 feet deep "the following materials were passed through, in the order mentioned, in layers, all of which were dipping away steeply to the east:—

"1. A breccia consisting of angular fragments of a fine-grained aluminous and siliceous rock, cemented together with a hard cement of oxide of iron and silica, throughout which are numerous blebs of quartz.

"2. A yellow ochre containing a fair percentage of oxide of bismuth.

"3. A brown iron ochre with veins of crystallised glassy quartz running through it.

"These ochres form the principal part of what has been passed through in the shaft. The two together must be at least 8 feet to 10 feet in width, and they contain numerous veins and bunches of oxide of bismuth.

"4. Earthy red hæmatite, with siliceous veins containing also broken particles and blebs of glassy quartz.

"All these materials contain gold in considerable quantity, the gold in some places being beautifully crystallised.

"Much doubt has been expressed as to the nature of this deposit. Both from the character of the stone and the regular manner in which it strikes and dips, I am of opinion that it is a lode, the breccia being formed by the breaking up and subsequent cementing together of particles of the walls and matrix of the lode. The fissure in which the lode is formed appears to have acted as the channel for the passage of water of hot springs to the surface, for all the materials, the crystallised gold, the hard siliceous and iron cement of the breccia, and the ochreous materials are such as would have only been formed by deposition from solution in water.

"The gold appears to be especially associated with the bismuth, for the veins of oxide of bismuth are exceptionally rich. A small sample of the oxide assayed by Mr. Hamilton contained 62 per cent. of metallic bismuth and 252 oz. of gold per ton of the material.

"A dyke of white felspar-porphyry can be traced down the hill from a point immediately south of the shaft in a west-north-west direction. It is very probable that this dyke may have influenced the richness of the lode at this point.

"In No. 1 and No. 2 North small quantities of gold have been found associated with the porphyry dyke.

"Mount Melville consists of massive blue slates and hardened sandstones, intersected by dykes of felspar-porphyry of a similar character, and probably a continuation of those met with in the northern part of Mount Shamrock. A

sample taken from the outcrop yielded gold equal to about 2 oz. 12 dwt. 13 gr. to the ton, but a trial crushing of 31 cwt. yielded only 4 dwt., or a little over  $2\frac{1}{2}$  dwt. to the ton.

"At the foot of this hill a small reef is being worked. It is from 2 to 10 inches wide, consisting of quartz with a large percentage of the oxide of iron and manganese. At the bottom of the shaft, in one place, there is a vein, 1 inch wide, consisting almost entirely of pyrolusite (oxide of manganese). An assay from this reef gave 16 dwt. of gold and 6 oz. of silver per ton. It intersects a dyke of porphyry. The foot-wall is of dolerite.

"At Mount Ophir is a large reef of white translucent quartz, stained in patches with oxide of iron. It contains a good deal of molybdenite and specks of iron pyrites. At 25 feet a hole was drilled into the reef; the *débris* obtained from the hole, on being washed, gave a very good prospect indeed. The rock of which this—the northern—side of Mount Ophir consists is made of fine felspathic dust containing small and more or less rounded particles of a micro-crystalline felspathic rock. Fine gold is obtained on crushing and washing pieces of this rock."\*

Mr. Rands, in the Report above quoted, gives an account of the Old Chowey Reefs and Stanton-Harcourt alluvial diggings, and of the Allendale, Hannan's, Union, Lady Mary, and other silver lodes. The argentiferous lead ores are associated with arsenical pyrites and zinc-blende. Mr. Rands observes: "The amount of silver in the lodes, as far as assays have at present shown, is small—only from 30 oz. to 40 oz. to the ton, which of itself will not pay to work, especially with a narrow reef. They all contain some gold. In the Allendale, which is the only shaft well into the sulphides, the ore contains as much as 1 oz. of gold to the ton. In 1886, the amount of ore raised was 75 tons, valued at £1,350. In 1887 the return was *nil*."

In a later Report,† Mr. Rands says:—"The deposit has been worked down to a depth of 215 feet, in the shape of a large square shaft about 40 feet across. This shaft was perpendicular down to a depth of 140 feet, from which point it inclines to S. at 40°, and to E. at 7°.

"In my former report on this mine, I said that the deposit was probably in the form of a 'pipe,' rather than a lode, and that the metallic minerals, and cementing materials, had probably been deposited from solution in water which has come up through fissures. The work since done bears out this opinion.

"For the first 50 feet the stone consisted of a breccia of fine-grained aluminous and siliceous rocks cemented together with a hard cement of oxide of iron and silica, a yellow ochre containing a fair percentage of oxide of bismuth, a brown iron ochre, and earthy red hematite with siliceous veins through it; and carbonate of bismuth in small pockets.

"At 50 feet in depth there was a large cavity filled in with a siliceous sinter, so light that it would float in water. Numerous such cavities, but smaller in size, have been met with at various depths.

"A tunnel has been driven into the deposit from the eastern slope of the hill, at a depth of 56 feet from the summit. This tunnel was in slates and stratified mud-rock, to a point 100 feet from the shaft, when the wall forming the boundary of the deposit occurs running W. 40° N. Prospects of gold can be got in this 100 feet, and it, or a part of it, will probably be worked at some future time.

\* Report on the Gold and Silver Deposits in the Neighbourhood of Mount Shamrock. By W. H. Rands. Brisbane: by Authority: 1886.

† On the Mount Biggenden Bismuth Mine, Gebangle, and the Mount Shamrock Mine. Brisbane: by Authority: 1890.

"There are numerous boulders of decomposed porphyry in the centre of the deposit at this level. On the western side of the deposit there is a dyke of kaolinite formed from decomposed porphyry; it is running north and south, and it is perpendicular.

"Slates are met with on the western side of this dyke, dipping north-north-east. There is a small vein of molybdenite very rich in gold in these slates.

"As the width of the working place is about 30 feet, the width of the whole deposit from east to west is about 140 feet at this level.

"Below the 50-foot level sulphurets began to appear, and there was comparatively little free gold to what was obtained near the surface. At 70 feet in depth the ore contained a great amount of iron pyrites.

"At 100 feet in depth a second tunnel has been driven into the hill to cut the deposit. Slates and mud-rock occur in this tunnel from the mouth to a point 78 feet from the main workings, when the wall forming the eastern boundary of the deposit is met with again, running W.N.W., and dipping S.S.W. at 70°. The deposit in the tunnel is in layers dipping to E. at 25°. Prospects of gold can be obtained throughout it, especially when the pyrites is in any quantity. The character of the stone in the portion being worked is much the same from this level down to the present depth—215 feet.

"It consists of fragmentary mud-rock, with a soft greyish tufaceous material, interlaced with veins and fissures, filled with sulphides of bismuth and iron, molybdenite, arsenical pyrites, quartz, lime, &c. There are some beautiful specimens of molybdenite with sulphide of bismuth imbedded in it. Tetradyomite—a telluride and sulphide of bismuth—occurs in small quantities in association with quartz. Small cavities occur in the deposit all the way down; these are often lined with well-crystallised minerals, among which I may mention beautiful needle-shaped crystals of bismuthinite, crystals of quartz, pearl-spar, and calcite.

"The manager, Mr. Higgings, informed me that the bismuth ore decreases in quantity at a depth. At 140 feet in depth a 'horse' or mass of mud-rock comes in on the northern side, and dips S. at about 40°, and from this depth the workings have dipped with it. At the bottom the size of the workings is 35 feet by 33 feet; but this does not represent the whole of the stone to be taken out, as the eastern and southern walls of the workings consist of stone of similar character to that being worked. The layers of the deposit dip away to the east from the 'horse' of mud-rock. There are large detached masses of a hard, very fine-grained rock at this level—one was so large that it was thought the deposit had cut out." . . . "A twenty-head battery is kept continually going, and up to the present time 11,864 tons have been crushed for a yield of 6,416 oz. 11 dwt. of gold, or an average of 10 dwt. 5 gr. of gold per ton.

"Tailings, estimated at 8,000 tons, from the crushings down to the 150-foot level, have been stacked. These are estimated to contain about 1½ oz. of gold per ton."

#### MOUNT BIGGENDEN.

This remarkable deposit of gold and bismuth is described by Mr. Rands\* as follows:—

"The workings are on a spur running up in a south-easterly direction to Mount Biggenden itself. The spur lies between one of the heads of the Two-mile Creek on the west, and a gully on the north-east.

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\* Report on Mount Biggenden Bismuth Mine, &c. Brisbane: by Authority: 1890.

"The high ridges to the west of the Two-mile Creek are of granite. The granite bends round to the east about a quarter of a mile up the creek, and crossing the creek, forms the range that divides the Two-mile Creek waters from those of Biggenden or Degilbo Creek.

"From the foot of the spur up to the mine, a distance of about 10 chains, the rock consists entirely of siliceous slates, which dip very steeply to the north-west. Above the mine is a bed of limestone about 70 feet in thickness, and above that again the slates occur, together with an altered sedimentary rock, containing quartz, felspar, hornblende, and olivine. Rocks of the same character occur on the ridge north-east of the gully, and right away on to Mount Biggenden itself.

"The Mount Biggenden deposit consists of an irregular mass of magnetite, somewhat semicircular in shape, bounded on the north by the slates and on the south by the bed of limestone.

"The following is a description of the deposits and workings:—

"*Cutting No. 1* has been driven into the spur in a southerly direction for a distance of 95 feet. The cutting is situated at the top of an inclined tramway, which runs down the hill to the Two-mile Creek.

"The first 12 feet of the cutting is in a light-grey soil with a few boulders of a fine-grained felspathic rock in it. The next 12 feet is of hard altered rock containing the minerals schorl, chlorite, and olivine. Then comes 6 feet of a decomposed dioritic rock, which has decomposed in concentric rings around kernels of the undecomposed rock. Next to this there is 9 feet of decomposed granite, and then 7 feet of a soft white kaolinite. From this point to the face of the cutting, which is 35 feet in height, is a mass of magnetite, lying in more or less horizontal layers. Near the surface, above the magnetite, there is a siliceous rock containing a large amount of arsenical pyrites.

"The magnetite contains numerous cavities, the sides of which are generally lined with well-formed octahedral crystals of that mineral; some of these cavities are filled in with calcite, while others are lined with decomposed radiating prismatic crystals, which I believe were originally hornblende.

"In and around the calcite there are also cavities containing a black powder consisting chiefly of the binocide of manganese. The oxide of manganese is generally rich in oxide and carbonate of bismuth.

"At the end of the cutting in the western corner there is a mass of this calcite of about 15 feet in length and 3 feet in height, in which some fine specimens of bismuthinite (sulphide of bismuth) have been obtained.

"The magnetite contains a little bismuth throughout it. A large amount of ore has been taken and stacked for treatment from this cutting, but owing to the difficulty of concentrating it up to a sufficiently high percentage of bismuth, it has not been sent away. The difficulty lies in the separation of the oxides and carbonates of bismuth from the magnetite, as their specific gravities are so much alike; the average specific gravity of the oxide of bismuth being 4.3, carbonate of bismuth 6.5, and that of magnetite 5.2.

"After washing a dishful of this ore as carefully as possible, 700 out of 900 parts of the concentrates were of magnetite, and could be extracted with a magnet. This cutting was not being worked.

"*No. 2 Cutting* is situated about 100 feet south-east of the mouth of No. 1, on the eastern fall of the spur, and at 15 feet higher level than No. 1.

"The ridge is much steeper on the eastern than on the western fall. The bed of limestone is 70 feet south of this cutting. It is an open quarry, with a face 30 feet in width and 22 feet in height.

"In the face of this quarry there is a large mass of crystallized calcite, 11 feet in height from the floor and 27 feet in width. Magnetite occurs on either side of this calcite, which appears to have filled a large cavity.

"There are numerous pipe-shaped and circular cavities; these, and all the joints, are filled with a fine dust, consisting chiefly of black oxide of manganese and a little cobalt, from which fact this working place has received the name of the 'cobalt cutting.' The percentage of cobalt is very small. Dr. March, of Maryborough, gives two analyses of this black dust:—

Bismuth ...	...	...	...	...	...	...	44.45
Cobalt ...	...	...	...	...	...	...	4.75
Nickel ...	...	...	...	...	...	...	0.68
Iron ...	...	...	...	...	...	...	13.55
Manganese ...	...	...	...	...	...	...	9.75
Lime and magnesia ...	...	...	...	...	...	...	19.92
Silica ...	...	...	...	...	...	...	6.90

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100.00

"Of a second sample he says—'It consists of black oxide of manganese with 5.97 per cent. of cobaltic oxide.' Messrs. Johnson and Matthey return only 2 per cent. of cobalt. The first sample was exceptionally rich in bismuth.

"Native bismuth, the oxide and carbonate of bismuth, and at times a little sulphide of bismuth, occur in this dust. The native bismuth is generally adhering to the calcite, and is often in the form of 'casts' of the rhombohedral crystals of calcite, showing that it must have been deposited there subsequently to the calcite.

"Four pieces of native bismuth were found in a small cavity, weighing together 36 lb.; small pieces up to 4 or 5 oz. in weight are continually being obtained.

"Small crystals of aragonite often encrust the calcite of these pipes. Some of these pipes are 2 or 3 feet in diameter and several feet in length.

"During my visit oxide of manganese was found coated with the mineral erythrine—a hydrated arsenide of cobalt. This mineral is of a peach-blossom colour, and reniform in shape. At present it has only been found in small quantities; when found in quantity it is very valuable for the manufacture of 'smalt'—a blue pigment. I believe this is the only occurrence of this mineral known of in Queensland.

"Around the calcite is a layer of soft material rich in bismuth ore, and above this layer is a quartzose rock containing arsenical pyrites and specks of metallic bismuth. This rock will require crushing machinery to extract the bismuth if found in sufficient quantities. Near the mouth of the cutting is some jasperized quartzose rock.

"*No. 3 Cutting*—known as the gold cutting—is on the western slope of the ridge. It is 105 feet south-west of the face of No. 1 Cutting. It is almost entirely in a soft aluminous rock—probably a decomposed porphyry. Near the face there is a band of decomposed granite, which carries a little gold and dips to the south. A mass of magnetite lies above the aluminous rock. Carbonate of bismuth occurs in this cutting; it is coloured green with silicate of iron.

"Gold has been traced along the surface, by means of small pot-holes, between this and No. 1 Cutting. The prospects, however, are very small, and do not represent more than 2 dwt. to the ton. The manager reports that he has quite lately

obtained bismuth ore, and gold equal to about 4 or 5 dwt. to the ton, in one of these holes, in a decomposed rock containing hornblende. He adds that it is free from magnetite, and will dress-up to 15 per cent. of bismuth, and probably 3 or 4 oz. of gold to the ton.

"A shaft, 42 feet in depth, has been sunk about 30 feet from No. 1 Cutting. It passed through—first, a decomposed rock with lumps of native bismuth and carbonate of bismuth; next through a siliceous rock containing a large amount of arsenical pyrites; then through 25 feet of calcite; and lastly through solid magnetite.

"The plan adopted for concentrating the ore is to first pass it through a half-inch screen; the coarser portion is afterwards hand-picked. All that goes through the screen is carted to a Cornish jigger, and put through with a mesh of 25 holes to the inch. Whatever passes through the jigger is then 'forked' in a streaming-box. By this method about 1 ton of concentrates is obtained from 20 tons of dirt. The manager has found streaming to answer much better than sluicing, as much less water is used, and much less of the finer bismuth ore is lost.

"With reference to the origin of the deposit, it is an irregular deposit. Its exact limits are not well defined, as the surface is covered with soil and large boulders of magnetite, which first drew the prospector's attention to it; but it is somewhat semi-circular in shape.

"The deposit in question extends but a short distance in any direction; its greatest length is under 400 feet, and its greatest breadth about 150 feet. It certainly is not in the form of a bed. I am of opinion that the iron came up from below in solution, perhaps as hydrated oxide; that it was precipitated as peroxide of iron, and that it was subsequently changed into magnetite—ferrous oxide and sesquioxide of iron—at the time when the surrounding rocks were altered; the calcite and other minerals—viz., the bismuth, manganese, and cobalt ores—being deposited subsequently in the numerous cavities in the magnetite.

"It is difficult, at present, to say much as to the commercial value of the deposit. It is being worked as a bismuth mine pure and simple. As far as the workings have at present gone they are mere scratchings on the surface, and the bismuth ores are only taken from the 'pockets' or cavities in the magnetite, and several tons of material have to be removed to obtain 1 ton of the 'dirt,' and 20 tons of this have to be concentrated to give 1 ton of ore containing about 10 per cent. of bismuth, worth £5 12s. per unit, or about £55 per ton. Mr. Roberts, the manager, reports that during October about 100 tons of dirt have been raised and treated for a yield of rather more than 5 tons of concentrates, averaging 10 per cent. of bismuth.

"The difficulty of separating the bismuth ore from the magnetite greatly limits the quantity of stone that can be treated."

#### GEBANGLE.

Several reefs, among which are the Mount Allen, Victoria, Lady Frances, Gebangle, Pride of Gebangle, Lord Nelson, Just-in-Time, Mount Toohey, Morning Star, Homeward Bound, and Grecian Bend, are described by Mr. Rands in his "Report on Mount Biggenden, &c." The field was opened in 1888. The country-rock varies from siliceous slates and greywacke to a "bedded volcanic agglomerate," granite and porphyry.

#### BROVINIA.

The existence of gold in this locality has been known for many years. It was, however, only in 1886 that the reward was claimed for the discovery of payable gold.

There are five reefs in the May Queen Claim. Ten tons of stone sent to Gympie gave a return of 1 oz. 14 dwt. of gold per ton. Machinery is about to be erected on the field.

In 1887, the total yield of gold from the Gayndah fields, which include Mount Shamrock, Gebangle, Chowie Creek, Stanton - Harcourt, River Bend, and Brovinia, is given as 3,348 oz. from 3,151 tons; in 1888, 3,810 oz. from 6,292 tons; in 1889, 1,793 oz. from 3,840 tons; in 1890, 2,791 oz.

#### PARADISE GOLD FIELD.

This new goldfield is situated partly in granite or porphyry country and partly in siliceous slates, which may be assumed to belong to the Gympie Formation. The following description is taken from a Report by Mr. Rands,\* who gives, in addition, a minute account of the different reefs. The Paradise and William Tell Reefs are in the "porphyry" country and the remainder in the slate.

"The Paradise Gold Field is situated on the south side of the Burnett River, about eight miles north-west of Degilbo Station, and about two miles below the mouth of Yarrabil Creek, the creek on which Gebangle is situated.

"Gold was discovered in reefs here about the middle of the year 1889, by Messrs. Allen and party. In my report on Gebangle, &c., published early in the year 1890,† I mentioned two reefs as being prospected in this district. Only during the last six or eight months, however, have any number of people been attracted to this field, and during that time fresh reefs have been discovered and prospecting has been going on apace.

"At the present time the population of the field is estimated at about 400.

"The reefs extend back for a distance of two miles from the Burnett River, and are situated on the steep ridges which lie between Scrubby or Paradise Creek and Finney's Creek. The site of the township is on the alluvial flat which fringes the river.

"The field at present is not a large one; it covers an area of from one and a-half to two miles in a north-and-south direction, by, say, an average of half-a-mile in an east-and-west direction. Very similar rock, however, extends over a much larger area, so that there is every probability of an extension of the area over which gold-bearing reefs will be found.

"The country-rock is for the most part a hard dark-coloured siliceous slate, with altered sandstone in places. It is only here and there that the dip of the slates is sufficiently defined to be determined.

"In the neighbourhood of the Paradise P.C. and Leishman's William Tell, and crossing the ridge along which the road to Mount Shamrock runs, there is a porphyry with a granitic structure, and consisting of about equal parts of quartz and felspar. The Paradise P.C. shaft has passed through this rock down to its present depth, 130 feet.

"All the way down Yarrabil Creek, from Gebangle to near its junction with the Burnett, slates and sandstones dip steeply to the north-west. On the north-eastern side of Scrubby or Paradise Creek, near its junction with the river, there are ridges containing thick beds of a white crystallized limestone running in an east-north-easterly

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\* Brisbane: by Authority: 1891.

† Report on Mount Biggenden Mine, Gebangle, &c. Brisbane: by Authority: 1890.



direction. I was unable to detect any organic remains in this limestone. Nearer the creek there was another bed of similar limestone running in a more northerly direction.

"The reefs run in various directions, but the majority of them have a more or less easterly and westerly bearing. Most of them are approaching the perpendicular; the Lady Margaret Reef, which underlies very flatly to the west, is a notable exception. Several of the reefs are small; in many cases they appear to be increasing in size at a depth, and the stone is quite as rich as in the narrower portions of the reef. The latest development in the Paradise P.C.—the deepest shaft on the field, where over 5 feet of quartz in width has been cut through at a depth of 130 feet—speaks well for the prospect of the reefs at a depth.

"The quartz has generally a faint bluish tint, caused by finely divided pyrites occurring throughout it. It contains also larger specks of pyrites and minute particles of galena and zinc-blende, though these latter minerals are by no means common. The gold exists in a very finely divided condition, and it is not often that it is visible in the quartz.

"So far as prospecting up to the present has gone, the gold appears to be disseminated very regularly through the reefs, and not to run in 'shoots' as is usually the case.

"The crushings amount in the aggregate to 552 tons, which have yielded 1,068 oz. of gold, or a little under 2 oz. of gold to the ton—an exceptionally good return when it is remembered that these crushings are from eight different claims, and from ten or eleven separate reefs.

#### RAGLAN, CALLIOPE, NORTON, CANIA, AND KROOMBIT GOLD FIELDS.

The Raglan Gold Field has been in existence since 1867. At the Old Diggings, the Two-mile Diggings, and the Mount Larcombe Scrub, considerable quantities of alluvial gold have been obtained. The country-rock consists of grey and siliceous slates, and hardened sandstones or quartzites, with occasional conglomerates and limestones. The limestone contains few fossils, but Crinoids are common, and a species of *Aviculopecten*, like *A. multiradiatus*, has been detected by Mr. Rands. This species occurs in the Gympie Beds, and the auriferous strata are probably of the age of the latter.

The Duke of Brittany Reef has yielded on an average a little over  $\frac{1}{2}$ -oz. of gold to the ton. About 1,000 oz. were obtained from the reef in a few years. Several other reefs have been worked from time to time. A copper lode has been opened up near the Old Diggings.

The Calliope Gold Field was discovered in 1863. "Gold has been obtained in fair quantities in the beds of nearly all the gullies heading from the Boyne Range. Amongst those on the Calliope Falls are the Nuggetty Gully, Dogleg Gully, Ten Men's Gully, and Gordon's Gully, all of which run westward into Oakey Creek, in Brennan's Flat. The gullies at the head of Brennan's Flat have also yielded gold, and in a gully close to the Sheep Station and running east a great amount of work has been done; the washdirt here was 10 to 12 feet deep. On the slope of the hill patches of alluvial of an older date than that in the gullies are now being worked.

"Nuggetty Gully, although very patchy, has been the most productive. In 1866, nearly 600 men were at work in this gully alone. The number had decreased to about 200 two years later on. Many nuggets up to 5 oz. have been picked up; and an American black is reported to have picked up nuggets weighing 14 oz. and 73 oz. respectively.

"On the eastern or Boyne side of the watershed are Machine Creek, Tucker's Gully, Pancake Gully, and New Zealand Gully. The latter, which was started in 1863, has been by far the most productive. A large number of men were employed in it in 1872.

"From over 800 men in the year 1864, the number has gradually fallen so that now (1885) scarcely a score are at present at work on the field. The future of Calliope will depend, therefore, rather on its reefs than on its alluvial deposits.

"The formation consists of metamorphosed rocks, chiefly of altered grey and greenish slates, with numerous outcrops of limestone and marble." These have yielded no recognisable fossils. "The country-rock is intersected by dykes and patches of serpentine diorite and porphyry."

Mr. Rands, in his Report, gives descriptions of the Theresa, King's Gully, The Company's, Perseverance, Connemara, John Bull, Alexandra, Mitchell, and Wood's Reefs, and observes that "up to the present time none of the reefs have had a fair trial. The deepest shaft is not more than 100 feet in depth; and, from the information I could gather, some of them at any rate have been abandoned for reasons such as want of capital, bad management, high rates for crushing, &c., and not because they did not contain gold in payable quantities, if worked in a judicious and economical manner."

The Norton Gold Field is at present the most prosperous of the group, probably for the reason that it has been fortunate enough to attract the attention of men of energy and skill. It was discovered in 1871, but little work was done till 1879, when a machine was erected.

The formation is a grey, medium-grained granite, which passes in places into syenite and in others into porphyry.

"The granite is in the form of an eruptive 'boss,' which rises through and sends out veins into the surrounding slate country.

"The granite is intersected by gold-bearing reefs and volcanic dykes of diorite, porphyry, and dolerite."

Mr. Rands describes minutely the Advance, Who'd-have-thought-it, Emu, Never Never, Little Wonder, Chandler's, Martin's, All Nations, Galena, and other reefs. In these the gold is associated with iron pyrites, arsenical pyrites, zinc-blende, galena, stibnite (sulphide of antimony), quartz, and calcite. From 1879 to 1884 inclusive, 2,766 tons of stone were crushed for 7,883 oz. of gold, but the treatment of the complex mundic proved the chief drawback to the development of the field. Lately, chlorination has been successfully applied to the treatment of the stone, and the field will probably develop steadily in future.

The country-rock of the Cania Gold Field is described by Mr. Rands as consisting of alternate layers of sandstone, slates, and limestone, the latter of a pisolitic structure and in parts fossiliferous. These rocks are capped by denuded tablelands of "Desert Sandstone." The limestones have yielded Corals and Brachiopoda, which render it almost certain that the auriferous strata belong to the same age as the Gympie Beds (Permo-Carboniferous).

"Colours of gold can be obtained from the drift in the beds of any of the creeks or gullies in the district, and most of them have been worked more or less. On the Cania or Three-moon Creek side of the watershed, the principal workings are the Four-mile Creek and its gullies. This creek has yielded large amounts of gold in rich patches, but it is not at all evenly distributed, and the beds cannot be followed any distance. Lower down on the same or west side of the

creek is the Moonlight Gully, which has given perhaps the best yields on the field, the gold being evenly distributed along the whole length of it. This and also the Chinaman's, Starlight, and Daylight Gullies all head from the same hill, around the foot of which the Three-moon Creek bends. Several reefs occur on this hill, some of which are being worked. On the other side of the creek, Paddy's Gully has proved the best."

In the Mount Rose Reef the gold is in white quartz; near the surface it was found in calcite. It is "met with in very rich patches, and at times over 100 oz. have been broken down in one patch. All the gold in this reef is coarse in character." The Garry Owen and Mount Hope Reefs crushed over 2 oz. to the ton.

"The Kroombit Diggings, on the other side of the watershed and west of Cania, were discovered in February, 1870, just a month before Cania was opened. Of the gullies on these falls the Roan Colt and Denny's have, perhaps, proved the best. They head from a small round hill which is itself partially covered with alluvial drift to a depth of 20 feet, which has yielded a fair amount of gold. There is another round-shaped hill about a mile to the east, which has also a similar drift on its summit. Gullies running also from the hill have been payable to work. The drift on these two hills is evidently of a date anterior to that found in the beds of the present creek or gullies. It is probably of Post-Tertiary age."

The above quotations are from Mr. Rands' "Report on the Gold Fields of Raglan, Calliope, Milton (Norton), and Cania, &c."\*

The returns from these fields are very incomplete. Prior to 1877 I have only been able to find records of the output of 1866 and 1868. The best years of the alluvial diggings, as will be seen from Mr. Rands' report, are omitted. An estimate of 2,000 oz. per annum for the eleven omitted years is probably well within the mark, and this, with the recorded output, brings the total yield up to 70,192 oz.

#### YIELD OF RAGLAN, CALLIOPE, NORTON, CANIA, AND KROOMBIT GOLD FIELDS.

Year.	Stone Crushed.	Yield therefrom.	Alluvial Gold.	Total.
	Tons.	Oz.	Oz.	Oz.
1863 to 1865 ... ..	...	...	...	say, 6,000
1866 ... ..	...	...	...	3,235
1868 ... ..	...	...	...	3,960
1869 to 1876 ... ..	...	...	...	16,000
1877 ... ..	107	1,209	791 ?	2,000
1878 ... ..	222	956	329 ?	1,285
1879 ... ..	926	1,517	...	1,517
1880 ... ..	785	3,430	...	3,430
1881 ... ..	823	2,072	998 ?	3,070
1882 ... ..	...	(No returns)	...	3,996
1883 ... ..	463	1,172	594	1,766
1884 ... ..	817	1,550	583	2,133
1885 ... ..	687	1,469	631	2,100
1886 ... ..	841	2,166	1,072	3,238
1887 ... ..	1,067	2,610	1,170	3,780
1888 ... ..	1,752	3,731	590	4,321
1889 ... ..	1,020	2,963	1,134	4,097
1890 ... ..	3,008	3,409	855	4,264
		Total ...	...	70,192

\* Brisbane: by Authority: 1885.

## ROCKHAMPTON GOLD FIELDS.

(EXCLUDING MOUNT MORGAN.)

## CROCODILE, ROSEWOOD, MORINISH, RIDGELANDS, AND CAWARRAL.

The Crocodile Gold Field lies at the foot of the north-west escarpment of the tableland on which Mount Morgan is situated, and can hardly be more than from 1 to 300 feet above the sea-level, on the heads of Gavial Creek, which falls into Keppel Bay thus proving, by the way, the falsity of an obstinate superstition among miners to the effect that payable gold *cannot* be found on the east coast. This belief, or rather its logical converse, that any gold found on the east coast cannot be payable, has exerted a powerful depressing influence on all such shows, as miners could hardly be induced to give them a trial. The prevailing country-rock is granite or syenite, and in this are the Hector, Who'd-have-thought-it, Block and Pillar, Hit or Miss, and other reefs. The St. Gothard and Bonanza are in altered stratified rocks—slates, greywackes, grits, and conglomerates—intersected by diorite dykes.

At the Rosewood Gold Field the Golden Bar Reef is composed for the most part of calcespar and chlorite, in pockets, and coating crystals of calcite. Sometimes there is also a good deal of quartz, and crystalline pyrites occurs in films on the surface of the veins. Some very rich bunches of gold have been obtained in calcespar veins in this mine.

The reef occurs in a diorite dyke, which is mostly altered to chlorite. Rich bunches have also been obtained in the Caledonian Reef, a large body of quartz with patches and pockets of chlorite, intersecting highly altered sandstone country.

At Blackfellow's Gully three reefs—the Homeward Bound, Carnarvon Castle, and Mary Florence—have been worked.

At Morinish the Welcome Reef has been worked to a depth of over 350 feet in a country-rock of fine-grained serpentinous greywacke. The reef is of quartz, with iron pyrites, arsenical pyrites, a little galena, and a very little zinc-blende. It has been worked for many years with fair success.

At New Zealand Gully is the North Star Mine, in porphyry country.

At Cawarral the Galawa, Annie, Helena, and Annie Halliday, in serpentine country, have yielded good returns. The Cawarral serpentine, as has already been shown, is merely a product of the metamorphism of sedimentary rocks belonging to the Gympie Formation.

Most of these small fields have yielded a good deal of alluvial gold. A nugget weighing 258 oz. 11 dwt. was found at Mount Wheeler (Cawarral).

The output of the various Rockhampton Gold Fields cannot be correctly given, as the earlier records are lost in the mists of an antiquity of over thirty years. In 1866, the Warden estimated the amount of gold at 1,000 oz. per week—52,000 oz. for the year. In 1867, the amount is given at 33,739 oz. In 1868, the total is given at 25,505 oz., of which 8,982 oz. were the yield of 7,564 tons of stone crushed. A total of 111,244 oz. is thus accounted for in three of the years previous to 1877, when returns began to be regularly published. It is probably well within the mark to assume that the total yield for the period amounted to about 200,000 oz. From 1885, or, perhaps, from 1884 to 1887, the returns from the field are mixed up with those from Mount Morgan. In 1887 the yield for the whole of the fields, excluding Mount Morgan, was estimated by the Warden at 1,600 oz. In 1888, the total, including Mount Morgan, is estimated at 117,800 oz., but the amounts from the different fields are not stated. In 1889 the yield from mines in the district, other than Mount Morgan, is estimated at 2,130 oz., but this is stated to be "exclusive of alluvial." In 1890, the yield from mines other than Mount Morgan is estimated at 6,131 oz.

## YIELD OF ROCKHAMPTON GOLD FIELDS (Exclusive of Mount Morgan).

Year.				Stone Crushed.	Yield therefrom.	Alluvial Gold.	Total.
				Tons.	Oz.	Oz.	Oz.
1866	...	...	...	...	...	...	52,000
1867	...	...	...	...	...	...	33,739
1868	...	...	...	7,564	8,982	...	25,505
Estimated amount prior to 1877				...	...	...	111,244
				...	...	...	88,756
Total				...	...	...	200,000
1877	...	...	...	...	...	...	2,350
1878	...	...	...	1,120	733	...	2,071
1879	...	...	...	...	...	...	707
1880	...	...	...	...	...	...	1,353
1881	...	...	...	...	...	...	2,132
1882	...	...	...	1,092	2,016	...	2,107
1883	...	...	...	...	...	...	5,591
1884	...	...	...	...	...	...	*
1885	...	...	...	...	...	...	†
1886	...	...	...	...	49,086	...	‡
1887	...	...	...	17,645	85,205	100	1,600
1888	...	...	...	...	...	...	say, 1,600
1889	...	...	...	...	...	(Not estimated)	2,130
1890	...	...	...	...	...	(Not estimated)	6,131
Total				...	...	...	227,773

\* "Work at a standstill, except as regards Mount Morgan." Warden, in Annual Report, Department of Mines.

† No estimate, although several mines crushed.

‡ No estimate, although "great activity prevailed."

## YATTON GOLD FIELD.

The recently opened goldfield of Yatton is in a dioritic country-rock, intersected by dykes of silicated felsite. Some of the auriferous reefs, such as the St. Catherine, follow the usual laws of such deposits, but the majority are peculiar as regards the conditions under which the gold is found. The gangue-stuff, which is generally composed of brecciated lumps of diorite is veined with calcite and decomposed concretionary carbonate of lime, and occasional aggregations of carbonate of iron (siderite) and decomposed orthoclase felspar are met with. Some of the stone, composed of mixed quartz and reddish ferruginous carbonate of lime, shows gold very freely. The gold is flaky, like goldleaf. The reefs are as yet too undeveloped to say much about. 136 tons crushed in 1877 gave 74 oz. of gold, but these figures give no idea of the yield of the field, as the richest parts of many of the reefs probably never passed through the stampers. A good deal of alluvial gold had been taken from Yatton seven years before the proclamation of the field. The reefs are not yet sufficiently developed to give a true idea of their value, as they are mostly of a character of which miners have had little experience.

## GOOROOMJAM DIGGINGS.

Gooroomjam is situated on that portion of the Bunya Range which divides the sources of the Brisbane River from those of the Burnett. The diggings are confined to two gullies that descend from either side of the range. Monarrumbi Creek is worked for about half-a-mile in length, and the Dry Gully for even a less distance than this. The area mined upon consists entirely of greenstone, with the exception of the lower

portion of the workings on Monarrumbi Creek, where massive hornblendic slates crop out at the foot of the range on the north side of the creek, and granite on the point of the spur constituting the south bank. But I believe that the little quantity of gold found here has travelled from the tract of greenstone above, and that the whole of the gold has been derived from this latter rock. The only instances of vein quartz, locally termed "reefs," were in the Wild Horse and White's Claims, both being in greenstone.\*

### WARWICK GOLD FIELDS.

#### LUCKY VALLEY, TALGAI, CANAL CREEK, AND PIKEDALE.

These small goldfields have never attained to any importance. Mr. C. D'Oyly H. Aplin, in his "Report on the Auriferous Country of the Upper Condamine,"† says:—"Talgai, Thane's Creek, and Canal Creek are comprised within one continuous area of similar formation (probably Lower Silurian),‡ but between this and its eastern development at Lucky Valley there intervenes, along the immediate valley of the Condamine, a strip of about twenty-five miles of country occupied by sandstones, gravels, and conglomerates, belonging to the Coal Measure Series" [Ipswich Formation].

Lucky Valley is entirely an alluvial diggings.

Copper lodes, as well as auriferous mundic reefs, occur at Pikedale.

In a quartz vein on Duffer Gully (Lucky Valley) there are found "small, bright, foliated metallic plates and scales of tellurium, in which gold may be seen imbedded."§

#### YIELD OF WARWICK GOLD FIELDS.

Year.	Stone Crushed.	Yield therefrom.	Alluvial Gold.	Total.
	Tons.	Oz.	Oz.	Oz.
1867 ... ..	790	988	...	988
1868 to 1876 ... ..	...	(No returns)	(No returns)	...
1877 ... ..	325	390	(No returns)	390
1878 ... ..	572	736	(No returns)	736
1879 ... ..	40	60	...	60
1880 ... ..	199	160	(No returns)	160
1881 ... ..	416	326	(No returns)	326
1882 ... ..	648	648	(No returns)	648
1883 to 1886 ... ..	...	(No returns)	(No returns)	...
1887 ... ..	48	72	485	557
1888 ... ..	...	(No returns)	(No returns)	...
1889 ... ..	...	(No returns)	...	521
1890 ... ..	...	1,854	149	2,003
		Total ...	...	4,389

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\* C. D'O. H. Aplin, Report of the Government Geologist, Southern Division. Brisbane: by Authority: 1869.

† Brisbane: by Authority: 1869.

‡ Mr. Aplin does not give a list of the fossils on which this determination is based, and says that "in general aspect they resemble the fossils of Gympie."

Aplin.

## CHAPTER IX.

### THE PERMO-CARBONIFEROUS SYSTEM—*continued.*

#### THE GYMPIE FORMATION OUTSIDE OF THE TYPE DISTRICT—*continued.*

INCLUDING HODGKINSON, PALMER, MOUNT ALBION, SILVERFIELD, WATSONVILLE, AND CHILLAGOE.

**Mineral Areas—viz., Hodgkinson Gold Field, Northcote Antimony Mines, Mulgrave Gold Field, Palmer Gold Field, Cannibal Creek Tin Field, Mitchell Antimony Mines, Mount Albion and Chillagoe Silver Fields, Dry River Silver Field, Nebo Gold Field, and Sellheim Silver Field.**

The geological position of the Hodgkinson Gold Field has long been a debatable point in my mind, but I can now see my way to include it, at least provisionally, in the Gympie Beds.

This goldfield was described in detail by the Writer in a Report\* accompanied by two maps.

The stratified rocks of the Hodgkinson vary in fineness from shales to conglomerates. The shales consist of pure blue clay, sometimes (as for instance at the Rob Roy Mine) blackened by carbonaceous matter. The clay is divided into thin laminæ by the planes which mark the pauses in the process of deposition. Slaty cleavage is not entirely unknown, but it is so rarely met with and so uncertain in its direction, that it may be presumed that pressure of the sort which results in the production of cleavage has been very feebly exerted in this region. Alternating with the shales are strata of greywacke, whose materials are essentially the same although less comminuted. The component grains or granules of the greywackes have been partly derived from a basic felspar and partly from a hornblendic rock. The felspatho-hornblendic matrix contains minute flakes of mica and grains of quartz, both apparently derived from a granitic rock. According to the frequency and size of the quartz grains, the greywackes pass by fine gradations into grits and conglomerates. The latter, however, contain, besides quartz pebbles, pebbles of quartzite or hardened siliceous sandstone, porphyry, lydian-stone, dark shale, and limestone.

By carefully noting the dip and strike of the strata, wherever they appear at the surface in gullies or on hilltops, and laying down their direction and degree on the maps, a tolerably clear idea of the structure of the goldfield has been obtained. The different strata do not present such marked characteristics that they can be traced with confidence for long distances, although some of the conglomerates in Glen Mowbray have been followed for more than a mile. Conglomerates, however, are from their very nature—being the product of strong currents and powerful attrition—apt to be of very local occurrence.

Within the area embraced by the large map (the neighbourhood of Thornborough and Kingsborough), there is a marked connection between the geological structure and physical features of the field. This probably holds equally true of the outside districts, which have not yet, however, been mapped.

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\* Brisbane : by Authority : 1884.

The strata strike, on the whole, from north-west to south-east, the denuded edges coming to the surface in that direction. Their dip is usually towards the north-east, and at a high angle, approaching the vertical. But the lines denoting the outcrops of the strata, as will be seen from the map, bend or "bag" southward along an axial line passing to the west of the township of Thornborough. It is impossible to estimate exactly the thickness of the series of strata to which the goldfield belongs, as neither top nor bottom has yet been detected, and, moreover, the apparent thickness may be exaggerated by unsuspected replications among the denuded beds; but a minimum thickness at least may be arrived at with some confidence by assuming that, allowing for replications, and even for possible faults, the average dip to N.E. is no more than  $65^{\circ}$ . On this assumption a thickness of 4,000 feet may be presumed for the strata cropping out between the horizon of the Amy Moore Mine and the north-east edge of the large scale map, as measured to the south-east of Kingsborough. Measuring downward from this same horizon at Peak "N," in the Mount McGann Range, south-westward to Mount Grant (a line where the apparent thickness is not affected by the bending or bagging above referred to), a further thickness of at least 17,000 feet of strata is met with.

The detailed "Study in Stratigraphy" which the preparation of the large map implies has revealed nothing to suggest the idea of any break in the continuity of the deposition of the whole series of at least 21,000 feet of strata, unless it be the gathering, at the head of Columbia Creek, of a portion of the series which at the mouth of Caledonia Creek, only five miles distant, measures (at  $65^{\circ}$  of estimated average dip) about 10,000 feet, into a space which can contain, although the strata are vertical, no more than 1,300 feet. But I am inclined to think that the phenomenon may be explained by a thinning out of the sediments towards the south-east, though possibly the effect may be aided by a fault having a downthrow to the north-east.

The nearly parallel valleys of Caledonia Creek (Glen Mowbray) and the Hodgkinson River are bounded on the right or north-eastern side by the Mount McGann Range, and on the opposite side by the Mount Robert Range. These ranges have had their trend determined indirectly by the forces which compressed the strata of the district from south-west to north-east, and threw them into long folds from south-east to north-west. After the strata had been compressed into nearly as small a compass as they would go into—i.e., till they became nearly vertical—the further operation of the same pressure resulted in the formation of fissures along lines of weakness, which lines of weakness were found in the bedding-planes dividing the upturned strata from one another. These fissures, which are nearly, but not exactly, parallel with the outcrops of the strata, have been filled with a rock of great hardness, which, by its power of resisting denudation, has given rise to the Mount McGann and Mount Robert Ranges. Both of these ranges occur in zones in which the hard rocks in question are closely grouped together, while the intervening softer "country" has been channelled by the Hodgkinson River and Caledonia Creek into deep valleys. The material with which the fissures are filled forms veins or dykes, from three to forty feet in width, of pure silica in almost all of its various forms. It frequently resembles quartzite, and occasionally passes into ribbon-jasper or chalcodony. The veins are often so laminated parallel to their sides as to suggest that they may be beds rather than veins, but the mode in which they now and then cut across the adjacent strata, although preserving a general parallelism, sufficiently disproves this theory. Crystallisation is comparatively rare, and the lamination seems to imply deposition of silica during the passage of copious sheets of hot water charged with the mineral in solution rather than the segregation of the silica from the surrounding strata. The veins (which they hardly are in the usual sense of the word), as laid down on the map, are very



striking; but in nature they are more remarkable still. They can be followed from hilltop to hilltop, forming at times rough insurmountable walls a hundred feet in height—as, for example, in the peaks west of Mount Tenison Woods. In other places denudation has left their remains on hillsides or hilltops in the form of huge cubes of hard quartzite, from which the surrounding softer rocks have crumbled away. These cubes stand up weird and solitary, like the “perched blocks” of Alpine and Arctic lands. The linear persistence of the veins in question is very remarkable. One, for instance, has been traced (with a few breaks) from Mount McGann to the head of Tyrconnell Creek, a distance of over six miles. The two veins intersecting Mount Robert have been followed for four miles each. In these and many other cases the tracing of the veins was abandoned for no other reason than that the limit of the map had been reached. Similar veins, it may be here observed, have been noted by the Writer in the Cloncurry and Leichhardt region, where they attain still more gigantic proportions. The veins of the Cloncurry and Hodgkinson resemble the dolerite dykes of Scotland and Ireland more than the ore-charged reefs of Australia. The Hodgkinson veins, I have been informed, contain rare and minute quantities of gold. I have not been able to verify this information, and suspect that the gold may have come from reefs adjacent to the veins. Specular iron ore, brown hematite, and binocide of manganese are not uncommonly found in the cavities of the larger veins.

In a conglomerate on the hillside, opposite the Glen Mowbray Machine, there occur some large oval pebbles or shingles of black shale. The shingles strongly resemble the Graptolite Shales of Victoria and the Uplands of the South of Scotland. But they are also quite undistinguishable from the beds of dark shale which lie beside, and geologically both above and below, the conglomerate bed. I split open a great number of the shale shingles in search of graptolites, but without success. They yielded instead a number of reed-like plant-impressions, invariably too indistinct for determination.

Near the northern boundary of the township of Thornborough is the Chance Tunnel. The locality is about a mile south of the conglomerate in Glen Mowbray, and the strata cut in the tunnel occupy a horizon which may be estimated at 4,620 feet below that of the conglomerate. They consist for the most part of dark-blue shales (commonly but improperly known as slates), with alternations of hard, gritty greywackes and a few bands of fine conglomerate. The fine-grained greywackes yielded a “petrified snake,” which was sent to the Queensland Museum, and pronounced by Mr. C. W. de Vis to be a *Lepidodendron*, probably *L. australe*, McCoy.\* I visited the spot afterwards, and saw some flattened stems and twigs, which may have belonged to *Lepidodendron*, but from which all the characteristic markings had disappeared. My visit left no doubt on my mind regarding the *bona fides* of the discovery. I found among the shales numerous casts of crustacean or molluscan tracks, some reed-like plant-impressions, and a fragment of carbonised wood.

Even if the shale pebbles or boulders or shingle (as the case may be) of the Glen Mowbray or other similar conglomerate should in future yield recognisable fossils, I should not necessarily regard the fossils as “derived” from some older formation which had been upheaved and subjected to denudation during the period marked by the deposition of the conglomerate. On the contrary, I should believe the fossils to be of practically contemporaneous origin. I believe the plant-remains of the Glen Mowbray shingles must have been derived from a bed of shale which formed a part of the same formation. In my field experience nothing is more certain than that fragments of a given shale bed will be found in any succeeding bed of conglomerate. The explanation

\* This has since been confirmed by my Colleague, who was allowed, by the courtesy of Mr. De Vis, to examine the specimens in the Queensland Museum.

is, I believe, to be found in the sun-drying and peeling-off of flakes of the shale and their subsequent partial rounding by attrition. I say this by way of caution against hasty conclusions from future discoveries. In the very probable event, for instance, of the discovery in shale-shingles of a determinable fossil—say, *Lepidodendron australe*—the conclusion would be that the conglomerate containing the shingle was deposited in a geological age subsequent to the deposition of the shale containing *Lepidodendron australe*, and, in my belief, the conclusion would be erroneous.

At the intersection of the road from Thornborough to Glen Mowbray with that which leads up to the Pioneer and Tichborne Mines is the outcrop of a bed of conglomerate, in which pebbles, up to six or eight inches in diameter, are closely packed in a matrix of greywacke. Of these pebbles some are of greywacke, the majority quartz, and a fair proportion blue coralline limestone. Similar limestone pebbles are found in conglomerates in a number of other places—e.g., on the hill west of the City of Dublin Reef, on the roadside in Glen Mowbray, near the junction of the Thornborough and Kingsborough roads, in the gully west of the shambles in Glen Mowbray, and in Tyrconnell Creek, north of the Honest Lawyer.

As in the case of the shale-shingles of the Glen Mowbray Conglomerate, I considered it very doubtful whether the fossils in the limestone pebbles were really “derived” from an older formation, having observed that the shingles on the Pacific coast of the present day contain numerous pebbles and boulders of coral drifted from the Barrier or other reefs. In this view I was subsequently confirmed by the discovery, about a mile and a-half south-west of Beaconsfield, of a conglomerate with similar pebbles containing similar fossils, almost immediately adjoining a bed of limestone which has been quarried for mortar for the Antimony Smelting Works at Northcote. This bed of limestone is vertical, four feet at least in thickness, and strikes north-north-west, as do all the strata in the neighbourhood. The limestone was found to contain a number of corals and shells, among which my Colleague has recognised *Pachypora*, *sp. ind.*, and *Cyathophyllum*, *sp. ind.* (Pl. 3, f. 10). Without attempting to name any more of the corals, which are in indifferent preservation, it is easily seen that several species are common to the limestone bed and to the limestone pebbles in the conglomerate. The corals which weather out in relief from the limestone pebbles of the conglomerate may therefore be ranked as contemporaneous with the strata of the goldfield.

The discovery of *Lepidodendron* in the Gympie Beds at the Training Wall Quarries, Rockhampton, removes one formidable objection to classing the Hodgkinson Beds with the Gympie Beds. As long as *Lepidodendron* was believed to be confined to the Star Beds, its occurrence in the Hodgkinson strata seemed favourable to placing the latter on a horizon near the former. We have here a second instance of the occurrence of *Lepidodendron* associated with a marine fauna in one and the same bed.\*

The auriferous reefs of the Hodgkinson are well defined, and are divisible into two groups or orders. Those of the first group coincide in their strike with the strike of the strata in which they occur. To this group belong the Tasmanian, North Star, Outward Bound, Amy Moore, Vulcan, Britannia, Caledonia, Forget-me-Not, Von Moltke, Lady Mary, Mark Twain, Rob Roy, Garry Owen, Tyrconnell, Black Prince, Henry Grattan, Commodore, Lizzie Redmond, Hero, Pioneer, Hope, and others. In all the members of this group a general law may be observed. They underlie at right angles to the dip of the strata. This circumstance can only mean that the fissures were produced by the same pressure that upturned the strata. Each stratum would break along a plane of least resistance, which would be found at right angles to the planes of bedding.

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\* See Annual Report of the Department of Mines, N.S.W., for 1889, p. 239.

The second group, which comprises the Bismarck, King Atilla, Lady Anne, Providence, Flying Pig, Tichborne, Idaho, Explorer, Great Northern, Devon and Cornwall, Empress of India, Alliance, Mowbray, Honest Lawyer, Fourth of July, Columbia, and Eureka, runs mainly north and south and at right angles to the lines which denote the outcrops of the stratified rocks. Their underlie is always to the east. It is probable that they belong to a period subsequent to the first series of fissures.

The gold occurs in a matrix of laminated quartz, without much pyrites or galena (except in the case of some of the mines of the Eastern Hodgkinson). There is consequently little difference in the productiveness of the stone above and below the water level. Blanks are met with here and there in most of the reefs—*i.e.*, spaces containing neither gold nor quartz, but only a brecciated gangue of sandstone and shale fragments. The gold almost always occurs in rather narrow "shoots," most of which die out (although the quartz may continue) at less than four hundred feet in depth. There is, however, no reason to doubt that at greater depths other shoots will yet be discovered.

In addition to the reefs around the townships of Thornborough and Kingsborough, Deep Creek, Woodville, the Eastern Hodgkinson, and Northcote are or have been important centres of mining industry. Antimony lodes occur at Woodville and Northcote. At the latter large smelting works have been erected.

The strata of the Palmer Gold Field are in all probability of the same age as those of the Hodgkinson Gold Field. Between the Ida and Maytown the shales or slates and sandstones have a pretty uniform north-north-west and south-south-east strike, and are nearly vertical, with a slight dip to west-south-west. From Maytown, down the Palmer for about a mile, similar rocks, also nearly on edge, strike mainly north and south, with a slight dip to the west. Farther west the character of the stratified rocks changes; they become of a more altered type, consisting mainly of slates and schists. A limestone bed of immense thickness belonging to the same series runs south-south-east from Palmerville for at least twenty miles towards the Mitchell. I failed to obtain any fossils from this limestone, which is generally blue and unaltered, but at times becomes a grey crystalline marble. The same limestone is traceable from Palmerville northward. On the east side of the Cooktown and Palmerville Road, about four miles north of Palmerville, the limestone is vertical, and strikes north and south, and is accompanied by vertical slates (with a similar dip and strike), which occupy the floor of the valley or pass through which the road and telegraph line are carried. The limestone here is a grey, crystalline marble, although its surface is blackened by a crust of lichens. The only fossils observed were Crinoid stems, too imperfectly preserved for specific or even for generic determination. The limestone forms a cliff of about a hundred feet in height, which is weathered into the most fantastic and even grotesque shapes. The strata of this formation are succeeded unconformably by the Desert Sandstone on the right bank of the Palmer, from Palmerville up to Maytown.

Between Maytown and the head of Limestone Creek, a tributary of the Mitchell, the slates and greywackes of the goldfield strike for the most part north-west and south-east. The whole of the so-called "Limestone" District shows little but slates or shales and sandstones or greywackes, with a nearly vertical dip and a north-and-south strike. Occasionally beds of flinty lydian-stone are interstratified with the shales and greywackes. Between the mouth of Limestone Creek and the St. George and Mitchell Rivers, is a conglomerate containing pebbles of blue limestone. This conglomerate is exactly similar to the conglomerate of Glen Mowbray already described, and the shales and greywackes themselves bear such a strong lithological resemblance to those of the Hodgkinson Gold Field that the conclusion is irresistible that they are part of the same deposit.

The country-rock of the lead, silver, and tin-bearing region of Mount Albion, Irvinebank, Dry River, and part of Watsonville probably belongs to the same age as the Hodgkinson and Palmer Gold Fields. At Mount Albion the strata consist of thick-bedded, fine, grey, hard, siliceous sandstones, sometimes approaching quartzite, and always somewhat pyritous, and grey and dark shales. These rocks, in the mountain on which the Mount Albion, Lady Jane, and Barossa Silver Mines are situated, are intersected by numerous faults, which traverse the field in every direction, and cut it up into small pieces, the dip and strike being totally different in each of these sections.

The sandstone of No. 1 Lady Jane Shaft and the shale of the Mount Albion Mine at the depth of 114 feet are plentifully marked with plant-impressions, which, however, are quite undistinguishable.

At Silverfield, about a mile and a-half south-south-east of Mount Albion, similar strata, with, however, a larger proportion of shales, form the matrix of argentiferous galena lodes. The strata strike west-north-west and underlie at high angles to south-south-west, but do not appear to be disturbed by faults to anything like the same extent as the Mount Albion strata.

Similar strata extend from Mount Albion through Irvinebank to the Dry River at Newelltown, a distance of about forty miles. At Irvinebank numerous tin lodes occur in these rocks. At the Dry River numerous argentiferous galena lodes, some copper lodes, and a lode of magnetic ironstone occur among grey and black slates or shales and greywackes, together with a bed of blue limestone, striking north and south. I could not find any fossils in the strata worth preserving, although the limestone showed traces of corals on weathered surfaces.

In the Great Western District, near Watsonville, a group of tin-mines lies in a band of slates and greywackes, intervening between the granite of Watsonville and the porphyry of the dividing range between the Walsh and Herbert Rivers, in the latter of which the majority of the tin-mines of the Western District are situated. The band of greywackes and slates extends from east to west, broadening considerably to the east. The strata dip for the most part at comparatively low angles to the south-west. The deposits of tin and copper ores in this district have a marked tendency to leave the fissure lodes and replace to some extent the material of the stratified rocks.

In the neighbourhood of Mount Albion a series of shales, sandstones, and grits replace the porphyry, which has extended for some distance to the east. In this formation are the silver-lead mines of Mount Albion and Silverfield. These strata have a general east-north-east and west-south-west strike, while their dip may be either to north-north-west, or south-south-east, or vertical. In Mount Albion itself (the mountain), the sandstones and grits predominate, and the strata are intersected by a network of faults, between which they strike and dip in every direction. At the surface, the siliceous sandstones and grits of Mount Albion have an almost vitrified appearance, and might almost be classed as quartzites, and often weather in large spheroids, like granite blocks. When followed down in the mines, however, they have much more the appearance of ordinary unaltered rocks, the difference being apparently, to some extent at least, due to the loss of the "quarry water" in the strata exposed at the surface.

The road from Mount Albion to Georgetown, which runs at first southward down Albion Creek and then westward down Oakey Creek to near the junction of the latter with Gibbs Creek, traverses sandstones, grits, and shales like those of Mount Albion, dipping on the whole to the S.E. at about  $50^{\circ}$ , although the strata are much disturbed by faults, and the dip is frequently reversed. Near the last crossing of Oakey Creek the stratified rocks are replaced by a mass of porphyry, with round clear blebs of quartz, not very large orthoclase crystals, and a dark mineral, which may be weathered

hornblende, in the interstices. This rock weathers deeply, but quite differently from either the Herberton porphyry or the Watsonville granite. The surface is bestrewn with angular blocks, generally of not more than two cubic feet, with rounded angles. The porphyry continues to about one mile beyond the junction of the Georgetown coach road and the Chillagoe road, where the sandy grits and conglomerates of the Mount Albion type are again met with. The stratified rocks occupy the whole of the Chillagoe road from this point down Emu Creek, and across Sandy and Oakey Creeks, a distance of about thirteen miles. At the first crossing of Emu Creek the grits occur in very thick beds, and, as well as the accompanying shales, are nearly vertical, with a slight dip to the south. At the crossing of the creek half-a-mile beyond Leakey's Creek the Mount Albion grits are a good deal hardened. Blocks of a coarse conglomerate (with a gritty matrix and large pebbles of quartzite) have been carried down the creek. Where the road next crosses the river I ascended a mountain on the left bank, and found it to be composed of grits altered to quartzites, with some limited (? intrusive) masses of porphyry.

At the 32-mile telegraph post, which is near the road, porphyry rocks are again met with, at the foot of what is known as the Feather-bed Range. Ascending the range by the road, the mass of the range is found to consist of hornblendic granite, which is replaced by shales, sandstones, grits, and conglomerates on the head of Koorboora Creek, a tributary of the Tate.

From Koorboora Creek westward by the Koorboora Camp are massive altered grits and conglomerates, with a matrix resembling quartzite and containing some grains of quartz and some of plagioclase feldspar. Near the head of the creek on which the Koorboora Camp stands, these rocks are intersected by dykes of acidic felstone. The stratified rocks continue along the road west-north-west to between Bismarck and Granite Creeks. Occasionally the grits are somewhat ferruginous. At other times they occur in thick beds, and are sometimes pebbly or conglomeratic, with a quasi-vitrified matrix, and weather in rude spheroids like granite.

Between Bismarck and Granite Creeks the road crosses a belt of coarse porphyry of the Herberton type, intersected by dykes of compact yellow felstone. The porphyry here appears to pass into true granite, containing sparse crystals of black mica (biotite). From this point to Mount Lucy granite is the prevailing rock seen in the neighbourhood of the road.

A little beyond Mount Lucy the road to Muldiva strikes off to the left (south-west). At the junction of the roads beds of limestone are for the first time met with. Along the Muldiva road limestones are seen at intervals interbedded with thin flaggy quartzites, which latter are sometimes honeycombed with cavities from which limestone has weathered. These strike N. 20° W. and dip at high angles to W. 20° S. In about four miles from the turn-off of the road, and near the Muldiva Camp, the granite recommences. The road from Muldiva to Chillagoe, which joins the main road about a quarter of a mile east of Gorge Creek, also traverses strata of limestone and quartzite.

From Gorge Creek by the road north-westward to Zillmanton, and for a few miles beyond, the country presents alternations of comparatively flat land with ranges of limestone, which stand from one to four hundred feet above the level of the flats. The limestone is apparently in vertical beds, which strike on the whole to north-west and south-east, although there are evidently many changes in the strike. In some cases I am pretty certain that the trend of the short "ranges" does not correspond with the strike of the upturned beds. These strata between the limestones are comparatively rarely exposed, being covered, as a rule, by a considerable depth of red soil.

In the neighbourhood of Redcap the limestone beds, as shown by quartzites interstratified with them, strike west-north-west and dip at high angles to north-north-east. In this district many thick beds of coarse conglomerate are interbedded with the limestones and quartzites.

Between Zillmanton and Dargalong Camp, which lies about six miles to the south, a thick bed of limestone is first crossed on the left bank of Stockman's Creek. For the next two miles the track crosses grits, highly altered coarse conglomerates, and fine shales, the grits being recognisable without hesitation as of the Mount Albion type. To these succeed mica-schists, with a few interstratified beds of altered Mount Albion grits. In about a mile the mica-schists pass into gneiss, and ultimately into micaceous granite. For two miles further the track crosses granite country with numerous quartz reefs. At the end of the two miles mica-schist recommences, and in it, near the junction of the granite, are the silver lodes of the Delaney or Dargalong group.

There is no question in my mind of the continuity of the whole series of stratified rocks met with between Mount Albion and Zillmanton. The grits met with throughout the whole series are so characteristic and so peculiar that these rocks must have been laid down during the continuance of almost identical physical conditions, or, in other words, during a single geological period. The purely mechanical character of the deposits to the east of Mount Lucy is, however, in strong contrast to the conditions which must have prevailed during the deposition of the limestones north-west of Mount Lucy. But the interbedding of the Mount Albion grits with the Chillagoe limestones shows that the regions east and west of Mount Lucy, although forming different horizons, belong to the same geological period. In the absence, or almost entire absence, of detailed mapping, it is difficult at present to be certain of the relative ages of the two horizons, but from what dips have been observed I lean to the opinion that the calcareous horizon is higher than the purely mechanical.

The limestones are generally semi-crystalline or crystalline in texture, passing into white marbles, and yield few and very imperfect organic remains. Near the Dorothy Mine I obtained some specimens of Corals and Encrinite stems, but from their state of preservation I do not think that the most expert Palæontologist could determine either genus or species. Similar fossils were obtained from the quartzites associated with the limestones near Zillmanton, but in no more recognisable condition. A section of this fossiliferous rock shows, under the microscope, that some crystalline calcspar is still entangled in the silica skeleton, but reveals no trace of organisms. I am strongly inclined to believe that the Chillagoe Limestones will prove to be continuous with the immense beds of limestone extending from the Mitchell, near its junction with Limestone Creek, through Palmerville, across the Palmer, and along the Palmerville and Cooktown Road. I have elsewhere\* given my reasons for believing in the identity of the strata of the Palmer and Hodgkinson Gold Fields, and I think there is every probability that the Chillagoe and Mount Albion Beds will prove to belong to the same series. It may be observed that the Mitchell and Palmer Limestone bears a very marked lithological resemblance to the limestones of Chillagoe, and that the only fossils as yet recorded from the former belong to the same two classes as those obtained from the latter—viz., Corals and Encrinites—and are in the same unsatisfactory condition. The limestones of both regions, as well as the associated strata, present, as regards organic remains, a most striking contrast to the Devonian Limestones of the Broken River and the Burdekin, both of which teem with Corals and Brachiopods in perfect preservation.

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\* Preliminary Report by R.L.J. on Limestone District, part of the Palmer Gold Field. Brisbane : by Authority : 1888, p. 1.

In the Hodgkinson Gold Field, among the shales which alternate with sandstones, grits, and conglomerates, *Lepidodendron australe*, McCoy, has been detected. This plant is characteristic of the Star Beds (Carboniferous) and of the lower portion of the Newcastle (N.S.W.) Coal-Measures. The shales, grits, and conglomerates of the Hodgkinson probably represent the series of similar rocks—which, however, are somewhat more altered—extending from Mount Albion to Mount Lucy, although in the latter the few plant-remains which have been discovered are not in recognisable condition.\*

On the whole, the stratified rocks of the Mount Albion and Chillagoe Districts must for the present be regarded as equivalent to the Palmer and Hodgkinson Beds, and referred to the Gympie Division of the Permo-Carboniferous system. They pass, as has already been seen, into mica-schists, and finally into granites.\*

## A SECOND GROUP OF MINES IN CONNECTION WITH THE GYMPIE FORMATION OUTSIDE OF THE TYPE DISTRICT.

### HODGKINSON GOLD FIELD.

This goldfield extends from the divide between the head of the Hodgkinson River and Leadingham Creek (an affluent of the Walsh River), north-westward for about forty miles down the valley of the Hodgkinson. It has already been sufficiently described in a previous portion of this chapter.

#### YIELD OF HODGKINSON GOLD FIELD.

Year.	Alluvial Gold.	Stone Crushed.	Yield.	Total Gold.
To end of—	Oz.	Tons.	Oz.	Oz.
1876 ... ..	24,986	...	712†	25,698†
1877 ... ..	4,000	13,218	29,818	33,818
1878 ... ..	4,000	25,949	40,435	44,435
1879 ... ..	2,021	21,422	31,654	33,675
1880 ... ..	(Not estimated)	19,472	25,096	25,096
1881 ... ..	2,941	10,649	12,367	15,308
1882 ... ..	928	9,969	11,567	12,495
1883 ... ..	(Not estimated)	8,032	7,203	7,203
1884 ... ..	(Not estimated)	7,750	6,943	6,943
1885 ... ..	(Not estimated)	5,362	5,553	5,553
1886 ... ..	(Not estimated)	5,333	4,288	4,288
1887 ... ..	(Not estimated)	2,686	2,399	2,399
1888 ... ..	(Not estimated)	2,596	2,325	2,325
1889 ... ..	(Not estimated)	2,993	1,960	1,960
1890 ... ..	(Not estimated)	927	1,082	1,082
Totals ... ..	...	136,508	183,402	222,278

† Deduced from figures in Report of the Department of Mines for 1884, p. 11.

‡ Deduced from figures in Report on the Hodgkinson Gold Field. By R.L.J., 1884.

### NORTHCOTE ANTIMONY MINES.

The three principal antimony lodes, viz., the Emily, Craig's, and Matilda, occur within the limits of the Hodgkinson Gold Field, nearly in a line running north-west from the head of Leadingham Creek to the head of the Hodgkinson. This line coincides with the strike of the slate and greywacke country-rock, and with the trend of the

\* Report by R.L.J. on the Chillagoe and Koorboora Mining Districts. Brisbane: by Authority: 1891.

lodes. The lodes, however, underlie to the south-west, while the strata dip to the north-east. They are traceable for considerable distances on the surface, as quartz reefs stained with antimony oxide, and on being opened show large shoots of solid sulphide of antimony (stibnite). The Emily was worked for some time for gold; the recorded crushings, 382 tons 12 cwt., having yielded 315 oz. 13 dwt.

The Wardens' Reports mention that in 1877 several tons had been prepared for shipment, but as the price in Melbourne was only £12, nothing further had been done; that in 1881, Messrs. Denny and Co. were erecting smelting works; that in 1882, a quantity of ore had been raised; that in 1883, Messrs. Edwin Field and Son had erected large smelting works; that in 1884, 550 tons of ore had been smelted, yielding 145 tons of crude antimony, valued at £3,500, and that the company had suspended operations; that in 1885, 70 tons of ore, valued at £300, had been raised; that in 1889, 58 tons, valued at £215, had been raised; and that in 1890, the Emily Co. had raised and purchased 578 tons 4 cwt., and smelted 571 tons for a yield of 172 tons of crude antimony, and had also forwarded to England 1 ton 4 cwt. 1 qr. of regulus, and 19 tons of oxide (from flues), averaging 70 per cent., and had also forwarded two parcels of 7 tons 4 cwt., and 31 tons 5 cwt. of antimony ore from Woodville North (down the Hodgkinson below Thornborough). The value of the yield for the year is estimated at £4,816.

#### MULGRAVE GOLD FIELD.

The Mulgrave River has evidently at one time entered the sea in Trinity Bay, but has been deflected—probably by the flows of basalt which fill up its valley down to the point where it turns sharply round to the south to flow into the sea at Port Constantine. It is a magnificent river, and drains the north side of Mount Bartle Frere, the eastern edge of the Barron Tableland, both sides of the Bellenden-Ker Ranges, and the western slopes of the Malbon-Thompson Range. The Lower Camp, or Goldsborough, is on the left bank of the river, at its junction with Toohey Creek. The Upper Camp is about six miles south of Goldsborough, on the spur dividing Toohey Creek and the Mulgrave. The walls of the Mulgrave Valley are mainly of greywacke, slate, and quartzite; but between the Lower and Upper Camps flows of basalt fill up the lower portions of the Mulgrave and Toohey Creek Valleys. In following the track from the Upper Camp to Herberton the stratified rocks continue to the edge of the basaltic tableland of the Barron. The Fisheries track from the Mulgrave to Herberton, on the other hand, makes its ascent to the edge of the basalt tableland over granitic rocks. There are evidently two distinct periods of basaltic outflows; the first, that which "levelled up" the Barron Tableland, and the second, that which choked up, at least for a time, the Mulgrave and other valleys, which had been carved out of the tableland.

A good deal of gold has been got in the alluvia of the Mulgrave at and below Goldsborough, but no accurate statistics are now obtainable. No serious attempt has as yet been made to search for gold *beneath* the newer basalt. The same may be said in this locality of the older basalt of the tableland, although the latter is continuous with the basaltic flows of the Upper Russell, beneath which payable drifts have been recently discovered.

At the Lower Camp are the Alice Reef, underlying to south-south-east at 70° (coincident with the bedding of the slates and greywackes), and the Cairns Co-operative Co.'s Reef, vertical and running west-south-west. At the Upper Camp are the Homeward Bound, Orient, Mowbray, Mabel, Scandinavian, and others. The reefs resemble in many points those of the Hodgkinson, and, although they cover only a limited area, some of them are likely to prove rich.



The following information regarding the yield of the Mulgrave is all that can be extracted from the Wardens' Reports, which are evidently imperfect, especially as regards alluvial gold obtained in the early days of the field.

YIELD OF MULGRAVE GOLD FIELD.

Year.	Quartz Crushed.	Yield of Gold therefrom.	Total Gold.
	Tons.	Oz.	Oz.
1879 ... ..	(No crushings)	...	440
1880 ... ..	(No crushings)	...	1,122
1881 ... ..	(No crushings)	...	784
1882 ... ..	442	446	502
1883 ... ..	174	302	302
1884 ... ..	29	230	302
1885 ... ..	222	260	275
1886 ... ..	100	262	262
1888 ... ..	115	327	327
1889 ... ..	(No crushings)	...	...
1890 ... ..	(Little work done)	...	...
	Total ... ..	...	4,316

## PALMER GOLD FIELD.

The Palmer Gold Field, so far as it has been hitherto opened up, occupies an area which may be roughly estimated at 2,300 square miles. This estimate, as in all other cases, has no relation to the area of the proclaimed goldfield. The greater part of the goldfield is occupied by shales and sandstones in strata, which are tilted up so as to strike from north and south to north-north-west and south-south-east, nearly vertical, but dipping slightly to west and west-south-west. Associated with the sandstones and shales, and obviously part of the same series, is a belt of limestone, traceable from four miles north of Palmerville southward to the Mitchell River. These stratified rocks have not suffered any appreciable degree of metamorphism; but owing to lateral pressure the shales have occasionally been cleaved so as to become true slates. They are traversed by dykes of igneous rocks (dolerite and diorite) of much later date. Regarding the age of the stratified rocks, no direct evidence has yet been discovered, the shales and sandstones having yielded only undistinguishable plant-remains, and the limestones only traces of *Enerinites* and *Corals* of indeterminable genera. From the lithological resemblance of some of the beds, however, to others found in the Hodgkinson Gold Field, it may be inferred that the Palmer rocks are identical with those of the Hodgkinson—*i.e.*, they belong to the Gympie Formation.

Nearly 92 per cent. of the gold hitherto obtained from the Palmer has been alluvial gold. The reefs in the neighbourhood of Maytown generally strike west-north-west and north-north-west, and underlie toward the south and west. Those at Limestone may be arranged in three groups—the first, running north and south and underlying to the west; the second, east and west, and underlying to the north; the third, north-east and south-west, some underlying north-west and some south-east. The Normanby group of reefs follows no definite rule in their bearing and underlie.

As will be seen from the following table, the reefs have yielded, from 1874 to 1890 inclusive, 105,548 oz. of gold.

The yield from this source reached its maximum in 1876, the third year of working. This was owing, in the first place, to the ease with which gold could be extracted

from the surface stone, and in the second place to the comparatively large number of European miners then on the field, who had been originally attracted by the alluvial diggings. The reefs, however, at present show signs of increased activity and productiveness.

The production of alluvial gold reached its maximum in 1875, the third year of the existence of the field. The bulk of the total output of 1,210,598 oz. of alluvial gold from 1873 to 1890 has, unfortunately, been reaped by Chinese.

North of the Palmer River the auriferous rocks are covered by a horizontal cake of the Desert Sandstone (Upper Cretaceous). This Desert Sandstone, there are cogent geological reasons for believing, may cover extensive deep leads of concentrated auriferous wash, which may yet prove even richer than the old alluvial diggings of the Palmer. It may be mentioned that the alluvial gold in many cases is found in localities where it is impossible to believe that it can have come from local reefs; and everything points to the old land-surface now covered by the Desert Sandstone as its original source. (*See Chapter on Desert Sandstone.*)

#### YIELD OF PALMER GOLD FIELD.

Year.	Alluvial Gold.			Reef Gold.		Total.
	Oz.			Tons Quartz.	Oz.	Oz.
*1873 ... ..	58,829			...	...	58,829
1874 ... ..	150,000			...	200	150,200
1875 ... ..	250,000			...	400	250,400
1876 ... ..	185,000			4,766	15,000	200,000
1877 ... ..	167,760			4,049	11,811	179,571
1878 ... ..	112,000			4,061	8,233	120,233
1879 ... ..	79,998			4,814	10,002	90,000
1880 ... ..	58,513			3,016	6,920	65,433
1881 ... ..	45,171			3,170	6,789	51,960
1882 ... ..	33,092			2,704	4,247	37,339
1883 ... ..	21,171			2,702	2,918	24,089
1884 ... ..	13,764			1,902	1,873	15,637
1885 ... ..	9,960			1,676	2,953	12,913
1886 ... ..	6,521			1,101	2,066	8,587
1887 ... ..	5,000			1,477	1,981	6,981
1888 ... ..	5,692			2,216	10,732	16,424
1889 ... ..	4,298			3,079	12,563	16,861
1890 ... ..	3,829			5,675	6,860	10,689
Grand totals ... ..	1,210,598			47,308	105,548	1,316,146

\* Deduced from data in Report of Department of Mines for 1884, p. 10.

#### CANNIBAL CREEK TIN FIELD.

Up to 31st December, 1884, 2,373 tons of tin ore, valued at £102,300 10s., had been exported from the Palmer Gold Field, chiefly from alluvial workings on Granite and Cannibal Creeks. Although this stream tin was collected from slate and greywacke country, and in the neighbourhood of the Cannibal Creek lodes, it probably came, for the most part, from the granite range to the east. This range, which is a stronghold of the Aborigines, has never been sufficiently prospected for lodes. The lodes on Cannibal Creek are large quartz reefs, running E. 15° S., through a country-rock of slate and greywacke, and containing some tin ore. The formation of a company to work these lodes resulted disastrously, as expensive machinery was erected before the mines were proved to be payable.

## YIELD OF PALMER TIN FIELD.

	Tons.					Estimated value.	
						£	s.
(Prior to) 1880*	...	...	...	450	...	22,500	0
1880	...	...	...	759	...	38,000	0
1881†	...	...	...	535	...	16,847	10
1882	...	...	...	360	...	11,340	0
1883‡	...	...	...	199	...	10,119	0
1884	...	...	...	70	...	3,556	0
Totals	...	...	...	2,373	...	£102,309	10

\* Exported by Whitehead and Co.

† Including, for the first time, Cannibal Creek lode-tin.

‡ Cannibal Creek Company wound up.

## MITCHELL ANTIMONY MINES.

Information has recently been received to the effect that very important discoveries of auriferous antimony ore have been made by Mr. J. V. Mulligan and others, on the Mitchell River near the Limestone Gold Mines.

## MOUNT ALBION SILVER FIELD.

West of the stanniferous porphyritic and granitic country of Herberton and Watsonville, a band of stratified rocks stretches north-westward from the head of the Dry River. They consist, for the most part, of shales and siliceous grits, the latter occasionally altered so as to be almost quartzites. Their general strike appears to be from north and south to north-north-west and south-south-east, but at Mount Albion itself, which is the most highly mineralised portion of the district, the rocks (among which siliceous grits predominate) have been minced up by innumerable faults into small segments, in each of which the strata have their own peculiar dip. In the Mount Albion Mine some sandstones are marked with reed-like plant-impressions, but nothing has yet been discovered sufficiently distinct to afford any positive evidence as to the age of the deposits.

In the principal mines on Mount Albion—viz., the Albion, Lady Jane, and Barossa—immense deposits of ore occur in a very irregular manner. It appears that the faults are even more numerous than the evidence observable at the surface would indicate, and that the ore has filled up fissures formed by faults which intersect one another in every direction, so that there are no definite walls which can be followed for any distance. The ores are earthy and ferruginous, with argentiferous lead oxides and carbonates, and probably a good deal of silver chloride in fine particles accounts for their occasional extraordinary richness (600 or 700 oz. of silver to the ton). Large “slugs” of horn silver are met with from time to time in the workings. In the Albion some were obtained at the surface and at the depth of nineteen feet. In the Lady Jane some were obtained at the one hundred and thirty and one hundred and eighty feet levels. The mines have not yet reached the water level, which is probably low, the mount being well drained by the faults which intersect it in every direction. Iron and lead oxides and carbonates, therefore, predominate, sulphide and sulphate ores forming, except in the Barossa (where the galena is associated with zinc-blende), only a small proportion of the ore.

In marked contrast to the deposits of ore on Mount Albion are those which occur about a mile and a-half to the south-east. A large lode, the Silverhill, which might be taken as a typical example of what is meant by a true fissure lode, runs north and south through slate country, underlying at 45° to W. It is distinctly traceable

across two hills and two gullies, for a distance of 1,500 feet, by occasional exposures of galena. In the workings the galena ore runs from nine inches to three feet in thickness, is occasionally associated with anglesite, zinc-blende, and pyrites, and is accompanied by a brecciform gangue of broken country-rock. The ore, although more than payable, is not nearly so rich in silver as that of Mount Albion. The mines at the Orient Camp, six miles north-east of Mount Albion, produce a similar class of ore to that of Silverhill.

Smelting works have been erected on Cummings Creek, Mount Albion, by Messrs. John Moffatt and Co., and the ores have been very successfully treated. The earthy ores of Mount Albion are mixed in due proportions with the galena ores of the Orient and Silverhill, and with ironstone and limestone from the Dry River. The bullion is cast into ingots of lead containing generally about 600 oz. of silver to the ton, and exported in this form.

Some confusion has arisen, owing to the Mineral Lands Commissioner having given in 1885 the amount of ore *raised*, while in 1886 only the amount *smelted* is given. Probably the amount smelted in the latter year included some of that raised in the former, so that the returns are defective for statistical purposes. The following notes embody all the information obtainable:—In 1885, 2,028 tons of ore were *raised*, containing 218,450 oz. of silver. Estimating the value of the ore on a basis of 3s. 6d. per oz. of silver, the value would be £38,229. In 1886, 1,440½ tons of ore *smelted*, yielding 223 tons of bullion, estimated to contain 88,224 oz. of silver; at 3s. 6d. per oz. of silver, the value would be £15,439: 340 tons of ore, valued at £22,446, are said to have been *raised* during the year. In 1887, 4,849 tons of ore were *smelted*, yielding 1,041 tons of bullion, estimated to contain 272,863 oz. of silver, and valued at £54,572 12s. How much was *raised* during the year is not stated.\* In 1888, 5,347 tons of ore were *smelted*, yielding 1,083 tons of bullion, estimated to contain 229,308 oz. of silver, and valued at £42,000. In 1889, 5,801 tons of ore were *smelted*, yielding 896 tons of bullion, estimated to contain 221,374 oz. of silver, valued at £55,683, besides 527 tons of sulphide ore exported to England for treatment, estimated to contain 96,818 oz. of silver. In 1890, 4,017 tons smelted, yielding 888 tons of bullion, estimated to contain 155,000 oz. of silver; besides 425 tons of sulphide ore exported, estimated to contain 65,621 oz. of silver; and 128 tons of ore forwarded to Aldershot, estimated to contain 10,368 oz. of silver.

These total values, for obvious reasons, cannot be added together.

#### DRY RIVER SILVER FIELD.

This field lies in the belt of mineralised stratified rocks which extends south-eastward from Mount Albion. The slates and greywackes which form the mass of the strata strike mainly north and south. The principal lodes—the Try-no-More, Dunn's, Silver Streak, Target, Silver Valley, White Star, and Rainbow—trend on an average from north-west to south-east, and underlie to the south-west. They have, as a rule, caps of ferruginous gossan showing lead oxide, galena, sulphate of lead, and carbonate of copper. In the Try-no-More, the ore at a greater depth is somewhat complex, being composed of copper pyrites, grey iron pyrites, galena, and zinc-blende. The other mines, however, yield chiefly argentiferous galena, with occasional zinc-blende. A smelting company commenced operations in 1883, and suspended operations in 1886. There is no doubt that several of the mines are distinctly payable. The failure of the field is

\* Except in Table A, where 1,041 tons and £54,572 are given, evidently by mistake, as the amount of ore *raised* and its value.

attributed locally to the policy of the smelting company, which was said to have been to force outside holders to sell their mines. The result is said to have been that ultimately these mines ceased to produce enough to keep the works employed. A decidedly good opening is offered by this field for a smelting work conducted on a more rational principle. There is a prospect of the smelting works being again set going, and several of the mines have recently been reopened.

For some years operations on the field were limited to the raising of limestone and ironstone, used as fluxes at the Mount Albion Works.

The following table gives extracts from the Mineral Lands Commissioner's Reports :—

#### YIELD OF DRY RIVER SILVER FIELD.

1883.—100 tons ore smelted yielded 18½ tons bullion, valued at £832.

1884.—200 tons ore raised, valued at £1,600.

1885.—500 tons ore raised, and dressed for smelting; estimated silver contents, 30,000 oz.; estimated value, £5,844.

("The Pacific Smelter had a trial run, and smelted 120 tons of ore for a yield of 42 tons of bullion, valued at £40 per ton; but smelting has again been suspended.")

1886.—420 tons ore smelted yielded 117 tons bullion; estimated silver contents, 22,230 oz.; estimated value, £4,668. ("But at present smelting operations are suspended.")

#### NEBO (MOUNT BRITTON) GOLD FIELD.

The reefs of the Mount Britton Gold Field occur partly in diorite and partly in grey and black shales and sandstones. The stratified rocks, which contain indistinct plant-remains, probably belong to the Gympie Formation, and the igneous rocks appear to be partly interbedded and partly intrusive. The field was opened in 1881 as an alluvial diggings, and has yielded some large nuggets—69 oz., 50 oz., 45 oz., 40 oz., and 35 oz.—with but a small proportion of fine gold. Two groups of reefs, one at the head of Nuggetty Gully and the other about three-quarters of a mile to the south, have yielded some rich crushings. Except the totals for the different years, no returns have been furnished by the Wardens. In the latter half of 1883, the Little Wanderer Reef crushed 421 tons of stone for 2,416oz. of gold. A third group of reefs, near Mount Clarke, looks as if it might yet prove valuable.

#### YIELD OF MOUNT BRITTON GOLD FIELD.

Year.	Alluvial Gold.	REEF GOLD.		Total Gold.
		Stone Crushed.	Gold therefrom.	
	Oz.	Tons.	Oz.	Oz.
1881 ... ..	4,808	(No crushings)	...	4,808
1882 ... ..	625 ?	627	2,779	3,404
1883 ... ..	520 ?	686	2,095	2,615
1884 ... ..	800 ?	200	500	1,300
1885 ... ..	...	(No returns)	...	...
1886 ... ..	say, 300	...	say, 50	350
1887 ... ..	450	12	16	466
1888 ... ..	268	...	489	757
1889 ... ..	68	28	94	162
1890 ... ..	95	22	34	129
Total ... ..	...	...	...	13,991

## SELLHEIM SILVER FIELD.

The majority of the argentiferous galena lodes of the Sellheim occur in an altered dolerite rock,\* which appears to have intruded among and spread over the denuded surfaces of a series of stratified rocks. A few of the lodes have been worked to a limited extent in the latter. The stratified rocks in question are best seen in Gordon Gully, which falls into the left bank of the Sellheim River, south of Eukalunda township. They have a general dip to S.W. at angles varying from 20° to 30°, and consist of bluish-grey shales and fine-grained sandstones, marked with faint impressions of fossils, among which I could detect *Spirifera*, *Productus*, *Pecten* or *Aviculopecten*, and *Stenopora*. Although the fossils obtained were all very imperfect, I have little hesitation in classing the strata in which they occur with the Gympie Beds. This series appears to be faulted on the east against granite and on the west against the Star Beds already described. It is in this neighbourhood that the *Chonetes*, &c., beds, referred to by Daintree and McCoy, occur.

The field is minutely described in a Report by the Writer.† The principal lines of lode are the Pyramid, Bonnie Dundee, General Gordon, and Rob Roy, some of them over half-a-mile in length. No smelting works have yet been erected, and, considering the expense of carriage of the ore to Bowen, it speaks well for the field that it has lived so long.

Bismuth mines (*see* Chapter II.) occur in the neighbourhood, but in granite or syenite country.

## YIELD OF SELLHEIM SILVER MINES.

				Ore Exported.	Value.
				Tons.	£
1883	...	...	...	20	400
1884	...	...	...	120	2,400
1885	...	...	...	278	5,165
1886	...	...	...	259	5,150
1887	...	...	...	207	4,215
1888	...	...	...	430	8,061
1889	...	...	...	132	2,462
* Totals				1,446	27,853

\* The return of silver for 1890 cannot be given, as the Commissioner's Report only gives the total of silver and bismuth ore as 53 tons 11 cwt., valued at £1,700 0s. 6d.

J.

\* *See* Mr. Clarke's Petrographical Notes.

† Report on the Sellheim Silver Mines and Surrounding District. Brisbane: by Authority: 1889.

## CHAPTER X.

### THE PERMO-CARBONIFEROUS SYSTEM—*continued.*

#### THE STAR FORMATION.

THE Star Basin forms an area of about thirty-six square miles, at the junction of the Great and Little Star Rivers, which are tributaries of the Upper Burdekin. Disposed with only a gentle dip, and consisting of unaltered stratified rocks, it contrasts in a striking manner with the surrounding granites, gneisses, slates, and schists. The latter, occurring between the Star and Keelbottom Rivers, and forming the country-rock of the Star Gold Field, and of the now much better known Silver Field of Argentine, as well as the stanniferous porphyry of Running Creek, are of much older date than the rocks which I named, in 1878, the "Star Beds," and which I then regarded (following Messrs. Daintree and R. Etheridge, F.R.S.) as Upper Devonian.

In a hill about three and a-half miles south-south-east of the Star Station a number of beds of coarse hard siliceous sandstone or grit, with quartz pebbles, rest on granite and dip to W. at an angle of  $12^{\circ}$ , presenting to the east an escarpment which rises some two hundred feet above the level of the granite. The same beds are seen in Horse Creek. Their total thickness cannot be less than three hundred feet.

On Dinner Creek, the beds which are seen in closest proximity are coarse grits and conglomerates, with pebbles of quartz and lydian-stone. Although these strata are probably on the same horizon as the grits of the hill referred to in the last paragraph, they dip at  $20^{\circ}$  towards the position where the metamorphic rocks appear at the surface. There is probably, therefore, a fault between the two formations at this place.

Where the Little Star River enters the Basin from the north, the lowest of the Star Beds open to observation are coarse gritty sandstones, containing a few pebbles and dipping to S. at an angle of  $30^{\circ}$ .

On the west side of the Great Star River, where the grits at the base of the series might have been expected to reappear at the surface, they were not observed. It is quite possible that they may have thinned out in the six miles that intervene.

Supposing the dip of  $12^{\circ}$  to continue without interruption from the grit of the hill down the course of Horse Creek, a series of strata equal to a vertical thickness of eight hundred feet should intervene between the grit and the strata next exposed to view, viz., about twenty feet of bluish shales, somewhat calcareous, which dip to S.E. at  $20^{\circ}$ , on the western branch of Sandy Creek near an old grave. The shales are covered with impressions of *Lepidodendron*. Similar shales, also rich in *Lepidodendron*-impressions, are met with on the eastern branch of the creek, where they are turned up on end. In this locality a fault probably divides the outcrop of the metamorphic slates, &c., from the Star Beds, concealing the lowest members of the latter series.

Next in ascending order, after a gap, estimated at thirty-five feet, is a bed of sandstone dipping to the south, and about ten feet in thickness, seen at the mouth of Sandy Creek. Above the sandstone, where Corner Creek falls into the Great Star River, are about twelve feet of green shales dipping at  $30^{\circ}$  to S.S.W. These shales are exceedingly rich in organic remains, among which the following have been recognised:—

*Lepidodendron australe*, McCoy.

„ *veltheimianum*, Sternb.

*Actinocrinus*, *sp. ind.*, Pl. 7, fig. 9.

*Beyrichia varicosa*, T. R. Jones, Pl. 7, fig. 15.

*Phillipsia dubia*, Eth.

*Fenestella multiporata*, De Kon.

*Spirifera bicarinata*, Eth. fil., Pl. 10, figs. 9, 13; Pl. 37, fig. 17; Pl. 11, figs. 1-3.

*Spiriferina*, *sp. ind.*

*Reticularia Urei*, Fleming.

*Retzia radialis*, Phill.

*Orthis resupinata*, Martin.

*Strophomena rhomboidalis*, var. *analoga*, Phill.

*Ohonetes cracowensis*, Eth.

„ *sp. ind.* (a), Pl. 13, fig. 10; Pl. 37, figs. 21, 22.

*Entolium*, *sp.*

*Euchondria*, *sp.*

*Nuculana*, *sp. ind.*

*Naticopsis variata*, Phill.?

„ *sp. ind.*

*Porcellia Pearsi*, Eth. fil., Pl. 15, figs. 7, 8.

*Orthoceras*, *sp.*

A gap of thirty-five feet intervenes between the fossiliferous beds of Corner Creek and the next succeeding, which is seen in Brock's Creek, viz., a bed of blue crystalline limestone at least twelve feet in thickness. Thin sections of the limestone, examined under the microscope, revealed no traces of organic remains.

About fifty yards further down Brock's Creek, and probably about ten feet above the last-mentioned limestone, are fifteen feet of hard yellow sandstones, among which there are some greenish calcareous bands, and hard shales, dipping to S. at 25° to 30°. In this section I observed a curious case of contortion in the upper beds not continued into the lower beds (see Plate 53, fig. 3). This local contortion I ascribe to the unequal contraction of the purely sedimentary sandstones and shales and the partly chemically-formed calcareous sandstone.

After a gap, probably not amounting to more than fifteen feet, the following section is seen in Donald's Creek, dipping to S. at 20°:—

	Feet
Blue shales with ironstone nodules, and impressions of <i>Lepidodendron australe</i> (McCoy), and thin hard limestone bands (upper beds at mouth of creek) ... ..	80
Impure blue limestone ... ..	2
Shales ... ..	15
Hard sandstone ... ..	1
Alternate bands of shale and fine, hard, calcareous sandstone, the sandstone bands containing shells, and the shales plant-remains ... ..	50
Hard sandstones and shales ... ..	70
Confused section, shales seen at intervals—room for ... ..	100
Fine dark-blue limestone or cement-stone, with conchoidal fracture, in three beds ... ..	3
Shales and hard sandstone, with <i>Lepidodendron</i> ... ..	20
Hard greenish sandstone (weathering spheroidally in parts), with <i>Lepidodendron</i> ... ..	30

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A bed of coarse conglomerate, twenty-five feet in thickness, seen in the Little Star River, north of the ford on the Coppermine Road, succeeds the uppermost beds



in the above section, a gap of probably about thirty-five feet intervening. The conglomerate is traceable on the surface for a mile and a-half. A band of porphyry, probably intrusive, although it follows the line of strike of the sedimentary beds, is seen in contact with the conglomerate in the Little Star River a few hundred yards above the ford.

A gap of about thirty feet is supposed to separate the last-mentioned conglomerate from the next higher bed, viz., a coarsely crystalline limestone, about one foot in thickness, seen in Horse Creek, and showing on its weathered surface sections of shells (*Orthis*, &c.), Encrinites, and Corals. A microscopic examination of the limestone matrix in which the larger fossils are preserved proved it to be a mass of foraminifera. The forms of the larger shells are perfect, but their substance has been entirely replaced by calcspar. Above this limestone lie about twenty feet of thin-bedded calcareous sandstones and shales, dipping to W. at 30°, and containing *Orthis*, *Chonetes*, and Gasteropods, together with *Lepidodendron australe*, McCoy. To these succeed twenty feet of shales and hard dark-blue sandstone, dipping to the south-east; also seen in Horse Creek, south of the Station Paddock.

Next in ascending order, after a gap of about twenty feet, is a coarse conglomerate of coarse pebbles, dipping at 60° to N.W., fifteen feet in thickness, seen in the Little Star River at the mouth of Horse Creek. Above this are about twenty feet of green shales and fine hard calcareous sandstones, seen in the Little River at the ford on the Coppermine road.

As no other area in the Star Beds has as yet been mapped in the like detail, the strata above described are thrown into tabular form for convenience in future comparisons.

	Feet.
Green shales and fine hard calcareous sandstones—Little River at ford on Coppermine Road ... ..	20
Coarse conglomerate—Little Star River, at mouth of Horse Creek ...	15
Gap ... ..	20
Shales and hard dark-blue sandstones—Horse Creek, south of Station Paddock ... ..	20
Horse Creek near Crossing of Star Road. { Thin-bedded calcareous sandstones and shales, containing <i>Orthis</i> , <i>Chonetes</i> , Gasteropods, and <i>Lepidodendron australe</i> ... ..	20
{ Limestone, with shells, encrinites, and corals ... ..	1
Gap ... ..	30
Coarse conglomerate—Little Star River, north of ford on Coppermine Road ... ..	25
Gap ... ..	35
Donald's Creek. { Blue shales, with ironstone nodules and impressions of <i>Lepidodendron australe</i> , McCoy, and thin hard limestone bands (upper beds, at mouth of creek) ... ..	80
{ Impure blue limestone ... ..	2
{ Shales ... ..	15
{ Hard sandstone ... ..	1
{ Alternate bands of shales and fine hard calcareous sandstone, the sandstone bands containing shells, and the shales plant-remains ...	50
{ Hard sandstones and shales ... ..	70
{ Confused section, shales seen at intervals—room for ... ..	100
{ Fine dark-blue limestone or cement-stone, with conchoidal fracture—in three beds ... ..	3
{ Shales and hard sandstone with <i>Lepidodendron</i> ... ..	20
{ Hard greenish sandstone (weathering spheroidally in parts), with <i>Lepidodendron</i> ... ..	30

	Feet.
Gap ... ..	15
Hard yellow sandstones, with greenish calcareous bands and hard shales—Brock's Creek ... ..	15
Gap ... ..	10
Blue limestone—Brock's Creek ... ..	12
Gap ... ..	35
Green shales, fossiliferous—Corner Creek ... ..	12
Sandstone—mouth of Sandy Creek ... ..	10
Gap ... ..	35
Bluish calcareous shales, with <i>Lepidodendron</i> —west branch of Sandy Creek ... ..	20
Gap ... ..	332
Grits and conglomerates—Horse Creek and hill to south, Dinner Creek and Little Star River ... ..	300
Total ... ..	1,353

White sandstones, pebbly grits, and conglomerates of considerable thickness, belonging to the Star Beds, overlie the mica-schists and slates of the Argentine Silver Field. They are inclined at comparatively low angles, and form cappings on the higher hills of the district such as Camp Hill, Ben Lomond, and the hill lying between the Bonanza and Caroline Mines.\* The section (Pl. 54, fig. 1) shows the relations of the sandstones, &c., overlying the silverfield to the Star Beds, as developed in the type district, and to the underlying rocks. It will be observed that the Star Beds sometimes overlie the slates and schists of the silverfield, and sometimes rest directly on granite.

In my Handbook of Queensland Geology,† I described, under the name of the "Dotswood Beds," a series of strata largely developed in the valleys of the Fanning and Keelbottom, which I then believed to succeed the Fanning (Burdekin) Limestone (Middle Devonian), conformably. To this horizon I referred the plant *Dicranophyllum australicum*, Dawson, occurring in a bed of sandstone immediately, and conformably, overlying the Fanning Limestone. I have since, as already stated, ascertained that the Fanning and Burdekin Limestones are succeeded by a great thickness of strata belonging to the same period (Middle Devonian), to which I have therefore relegated the plant in question. Moreover, I have since found in the "Dotswood Beds," as originally described, an abundant series of fossils which leave no doubt that the "Dotswood Beds" are identical with the "Star Beds," or at least are part and parcel of the same formation.

In Keelbottom Valley, near Dotswood, the strata of the so-called "Dotswood Beds" dip to E. at 30°, and form a series of ridges across the valley. Taking into account the high dip and the extent of ground occupied by the outcrop of the strata, they must be some thousands of feet in thickness. Beds of brown felspathic sandstone alternate with conglomerates and red shales which are marked conspicuously with white spots. The conglomerates contain pebbles, up to six inches in diameter, the majority of which are of pink porphyry, a few being of hardened white sandstone or quartzite. The porphyry pebbles, as well as the felspathic sandstones and the gritty felspathic matrix of the conglomerates, clearly prove that the deposit was derived, as a whole, from the waste of volcanic or metamorphic materials. It bears a striking resemblance to the Lower Old Red of Perthshire, Scotland.

\* See Map attached to Report by R.L.J. on the Argentine (Star) Silver Mines. Brisbane: by Authority: 1886.

† Brisbane: 1886.

On the left bank of the Burdekin, opposite Dalrymple, the strata are of a character essentially similar to those of Dotswood. They consist of reddish and chocolate-coloured sandstones, which are often cross-bedded, and sometimes flaggy, with faint ripple-marks. In places they enclose little pellets of chocolate-coloured shale. Buff ferruginous spots are common in the interior of the sandstone. The shales are occasionally greenish, but the red and chocolate-coloured beds predominate. The red and chocolate-coloured shales are dotted with white spots, and often weather spheroidally.

The little hill called Mount Keelbottom consists of a pale pinkish porphyry with a base of acidic felspar, crystal of orthoclase felspar, and water-clear blebs of quartz. The porphyry has a quasi-schistose structure which is specially noticeable on weathered surfaces. The same is observable in the hill immediately opposite Dalrymple, where a series of escarpments coincides in direction with the outcrop of the sandstone beds. It is more than likely that the porphyry is a metamorphosed volcanic tuff, but whether it is interbedded with the sandstone strata, or is of older date, has not been ascertained.

A visit to the Keelbottom River, in June, 1879, enabled me to include in the so-called "Dotswood" (Star) Beds the greater part of the Keelbottom Valley up to the junction of Speed Creek, and a considerable portion of the hilly region known as Table-top Downs. Leaving the eastward bend of the Keelbottom River, between the Plumtree Inn and Speed Creek, to ascend the hill on the eastern side of the valley, several low ridges are crossed composed of grey, greenish, and brownish sandstones, dipping at about  $30^{\circ}$  to E.S.E. The sandstones are generally in not very thick beds, are hard and tough, and occasionally weather spheroidally. Some of the brown beds are easily recognisable as having been derived from the waste of the adjacent granite. All the sandstones have a greater or less admixture of feldspathic granules with the siliceous. Towards the base of the hill, the sandstones become more conglomeratic than in the valley, the pebbles being of porphyry, quartzite, quartz, and various metamorphic rocks (gneiss, slate, &c.) The steep slope of the hill is of conglomerate. Near the top is a thick, conspicuous stratum of yellow cross-bedded sandstone, capped by amygdaloidal dolerite, about ten feet in thickness. The dolerite is again surmounted by yellow sandstone. The strata, when followed in ascending order at right angles to their outcrops, become gradually more and more mixed up with traphean beds (varying from dolerites to porphyrites), till, towards the Fanning, the intercalated sandstones are scarcely met with. These ancient lava-beds, especially the porphyrites, are cupriferous over a wide area. Large masses of native copper are found in the Keelbottom Copper Mine.

In 1886 I visited the range on the eastern side of the Keelbottom Valley, north-east of the Old Plumtree Inn (Boolangalla Town Reserve). On ascending from the old inn the slope was found to consist of coarse, white, hard grit and conglomerate, dipping at  $40^{\circ}$  to S.S.E. These beds are intersected by a sheet of intrusive porphyry which runs obliquely across the bedding. The porphyry forms the top of the mountain, which has a double summit, the two peaks being divided by the head of a gully which falls into the Keelbottom River. Below the scarp formed by the edge of the porphyry are some beds of grit and conglomerate, divided by flaggy beds of fine-grained grey sandstones and beds of shale. The fine-grained sandstones yielded *Spirifera bicarinata*, Eth. fil.; *Rhynchonella pleurodon*, Phill.; *Chonetes*, sp. ind. (a), Pl. 13, fig. 10, Pl. 37, figs. 21, 22; *Chonetes*, sp. ind. (c), Pl. 37, fig. 20, and numerous other fossils common to the Star Beds in the type district.

Mr. A. Gibb Maitland speaks in the following terms \* of a series of strata which he refers to the Star Beds:—

"It is with hesitation that I class a series of grits, sandstones, and conglomerates, occurring in the south-east corner of the country, with the Star Beds. No organic remains were detected in any of them.

"It is only their strong lithological resemblance to strata of that age in other areas that gives any clue to their geological position. They do not occupy a very extensive tract of country.

"The first locality in which these beds were met with is about north-north-east of Kangaroo Hills Station, and distant about eight to ten miles. They consist of coarse whitish quartzose grits and conglomerates, lying almost horizontally and forming conspicuous escarpments, traceable for some distance; they rest alternately upon granite and the upturned edges of a series of hardened grits and shales, which have a general north-east and south-west strike. Sect. IV., plate 1,† gives a general idea of their occurrence. Some little distance from Mount Fox to the north, about ten feet thick of a whitish quartzose grit resting on granite and dipping at 70° N.E., is seen to be overflowed by sheets of basaltic lava. Much lower down the creek boulders of grit were seen, but this is the only section where the rock is met with *in situ*. The section is shown Sect. I., plate 2.

"An extensive development of these beds is to be seen in the Blue Range, which occupies that piece of country drained by the tributaries of Tomahawk or Packsaddle Creek, Camel Creek, and some minor affluents of the Burdekin. In a traverse from the camp on Tomahawk Creek to the Blue Range the country was found to consist of shales and ferruginous felspathic sandstones or greywackes, in which no fossils were detected. These beds are nearly vertical, and strike north-east and south-west.

"The sedimentary strata which rest unconformably upon the vertical beds are arranged in the form of a synclinal trough, the longer axis of which appears to trend in a north-westerly direction. Scaling the first cliff formed by the denudation of the Star Beds, the quasi-vitreous white sandstones were found to dip S. at angles of about 35°; the trend of the mural precipice was east-south-east. The actual summit was ascertained by Aneroid to be 2,030 feet above sea-level. This mountain is almost isolated from the main mass of the range by a low saddle 1,620 feet above sea-level, and which divides waters flowing east and west. In this low saddle vertical ferruginous felspathic grits striking north-east and south-west crop out at intervals. After passing over a low table of grit, beneath which the vertical sedimentary beds are seen to lie, a hill 1,930 feet above sea-level was ascended and found to be capped with grits, which were seamed in places with veinlets of quartz. At the foot of the hill in the north-east these beds appear to be faulted against the vertical shales and greywackes. The highest point of the range was found to be 2,670 feet in height, and composed of coarse grit and conglomerate, with a vertical wall-like precipice over 100 feet in height facing the south-west. (Section II., plate 2.)

"From this point the general character of the range could be well seen, and its geological structure. Owing to darkness coming on, I was unable to visit the south-westerly end of the synclinal trough.

"Another minor area of what are regarded as representatives of the Star Beds is met with in the vicinity of Lake Lucy Station. Some distance west from the head station a conspicuous low hill is seen to be composed of a semi-vitreous white grit or quartzite, which appears to unconformably overlies the Wairuna Beds.

\* Report on the Geology and Mineral Resources of the Upper Burdekin. Brisbane: by Authority: 1891.

† Of Mr. Maitland's Report

"A gully flowing south-west from the divide, east-south-east of the station, and about three miles distant from it, another section showing a similar grit or quartzite is seen in a cliff which trends north-east and south-west."

Near the mouths of the Cape, Suttor, and Sellheim Rivers, a considerable area is occupied by the Star Beds, which cover the greater part of Harvest Home, Lornesleigh, and Mount McConnell Runs. They rest at their northern boundary on granite, and at their southern boundary, near the Sellheim Silver Mines, they are apparently separated by a fault from the Gympie Beds. They appear to be disposed in a basin, the synclinal axis of which is a short distance south of Mount McConnell Station. Near the silver-mines they dip to N.W. at angles varying from  $40^{\circ}$  to  $50^{\circ}$ . On the northern boundary, near Mount McConnell, the lowest beds seen, which form what are known as the Devil's Craggs, are white sandstones, hardened but otherwise not much altered, dipping at  $75^{\circ}$  to E.  $15^{\circ}$  S. The sandstone resembles lithologically those of the Star Beds near Dotswood. Between the Craggs and Mount McConnell Station occasional outcrops of stratified rocks, including quartzites, greywackes, flaggy sandstones, and shales, are met with, dipping at  $40^{\circ}$  to S.S.E. The quartzites have small dark flakes of carbonaceous matter. The greywackes, which are often calcareous, are full of lines of small holes, but I could see no distinct moulds of organic remains. On the road from Mount McConnell Station to Lornesleigh, three miles west of the former, I saw a felspathic sandstone full of stems of *Lepidodendron*, and another stem covered with circular leaf-scars (*Cyclostigma*?). Similar fossils, I am informed, are obtained at Lornesleigh and Harvest Home. *Lepidodendron australe*, McCoy, has been obtained at Harvest Home by Mr. P. W. Pears.\*

In Conrad's Dorf Block, about four miles south-east of Mount McConnell Station, sandstones and shales with plant-remains, including *Cyclostigma* (?), dip to N.W. at over  $45^{\circ}$ . About two miles to east-south-east, felspathic sandstones, shales, and black quartzose lydian-stone dip to N. at  $40^{\circ}$ . The sandstones and shales contain plant-remains. Where the Ravenswood Road crosses the Sellheim River, about three miles short of the Silver-Mines, there are some coarse conglomerates with a green matrix, and boulders of quartz and quartzite, as well as some green felspathic and quartzose sandstones, all dipping N.N.W. at  $45^{\circ}$ .†

In 1890 Mr. W. H. Rands made a traverse of this district, and reported as follows:—

"Six miles south of the range dividing St. Paul's Creek from Cattle Creek, after passing over a reddish sandy soil, flat beds of a fine-grained felspathic sandstone are seen in Cattle Creek, dipping E.  $10^{\circ}$  N. at  $20^{\circ}$ . Portions of the sandstone contain a large amount of iron in their composition, and weather red. Above this is a coarse sandstone or grit with the same dip.

"I found no fossils in these beds, but they are probably Star Beds (Lower Carboniferous) as they have the same strike and dip as beds of that age met with at Harvest Home and Mount McConnell Stations.

"Continuing southwards towards Harvest Home Station, sandy flats are crossed to within about a mile of the station, where a sandstone dips east-north-east. At Harvest Home, beds of sandstone, with thin beds of shale, dip E.N.E. at  $25^{\circ}$ . In these I discovered some not very distinct plant-markings (*Calamites*?).

\* See "Catalogue of the Queensland Court in the Colonial and Indian Exhibition" (London Edition), p. 154.

† See Geological Map attached to Report by R.L.J. on the Sellheim Silver Mines, &c. Brisbane: by Authority: 1889.

"On the south side of the Cape River, opposite to Harvest Home Station, a high ridge occurs coming down close to the river. On the northern flanks of this ridge are similar sandstones dipping steeply east-north-east against a felsitic rock, much resembling that of Mount St. Paul. The ridge is composed chiefly of this rock.

"The country is quite flat from here across the valley of the Suttor River.

"Along the road from Harvest Home Station to Lornesleigh Station, numerous outcrops of sandstones, sandy shales, and quartzites occur, having a general dip towards E. at from  $22^{\circ}$  to  $30^{\circ}$ . I could find no fossil remains in them. A large reef of 'buck' quartz crosses the road in a north-north-easterly direction about two miles east of the station.

"After crossing the Cape River at its junction with the Suttor River, near Lornesleigh Station, the road passes over alluvial flats for a distance of four miles. At this point beds of felspathic sandstone and sandy shales dip E.  $35^{\circ}$  S. at  $20^{\circ}$ . These beds are full of stems of *Lepidodendron*, *Calamites*, and *Cyclostigma*?—a stem with circular leaf-scars. I also found the nearly perfect remains of a fish, which Mr. R. Etheridge, Junr., says certainly belongs to the family *Palæoniscidae*, and probably is of the genus *Palæoniscus* itself.\*

"The ridges all about here consist of similar beds. About half-a-mile south of this spot there is a bed full of some small, somewhat tripartite nodules which I thought might be *Trigonocarpon*, but Mr. Etheridge pronounced them too badly preserved to determine.

"Between this and Mount McConnell Station, *Lepidodendron* occurs in many places in the rock. At that station the beds dip south-east.

"Along the road from Mount McConnell Station to Mount Wyatt, blacksoil flats are traversed for about two miles, and then there is a small boss of granite about two miles across; beyond this the Star Beds occur again, dipping to the north-west for five miles in a south-east direction, and then Gympie Beds come in.†

"*Lepidodendron* also occurs in the ridges about two miles east of the station, on the eastern side of the Sellheim River.

"Between Mount McConnell Station and Mount McConnell itself, which is about ten miles to the north, the beds are dipping S.E. at  $40^{\circ}$ . What are known as the 'Craggs' are on the western side of the road, about seven miles from the station. They are cliffs of hardened sandstone or quartzite of from 50 to 100 feet in height.

"The rocks immediately south of Mount McConnell consist of beds of sandstones, fissile shales, and conglomerates, dipping to the south-east at a high angle. The pebbles of the conglomerates consist chiefly of quartz, sandstone, and quartzite. About half-a-mile west of the mountain a thin bed of blue impure limestone dips S.E. at  $45^{\circ}$ . West of the limestone again, as far as the Suttor River, thin laminated shales occur dipping S.E. at  $35^{\circ}$ . These shales are full of segregated nodules, of from an inch to nearly a foot in diameter. I searched carefully for any fossil remains about here, but I was only successful in finding a few which were very indistinct.

"Mount McConnell itself is composed of felsite. The Star Beds occur as far as the Burdekin, and can be traced six miles or so down the river."‡

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\* The specimen was forwarded to Mr. A. S. Woodward, of the Museum of Natural History, London, who confirmed the reference to *Palæoniscus*, allowing for the absence of the head.

† Report on the Sellheim Silver Mines and surrounding District, by R. L. Jack. Brisbane: by Authority: 1889.

‡ Report on the Cape River Gold Field, by William H. Rands. Brisbane: by Authority: 1891, p. 16.

At Mount Wyatt, near the head of the Sellheim River, the late Mr. R. Daintree observed "slightly inclined grits and sandstones of the Upper Devonian *Lepidodendron* Beds, resting on the upturned edges of a series of blue and grey slates and shales," which have yielded fossils determined by Prof. McCoy, and referred by him to the Upper Silurian.\* The fossils from the "slightly inclined grits and sandstones of the Upper Devonian *Lepidodendron* Beds," as determined by Mr. W. Carruthers, F.B.S., and revised by my Colleague, from this locality, are *Lepidodendron australe*, McCoy, and *Cyclostigma*, *sp. ind.*

From Canoona, near Rockhampton, Mr. Daintree also obtained *Lepidodendron australe*, McCoy, and *Cyclostigma*, *sp.*, Feist., allied to *C. Kiltorkense*.† The former may, as has already been seen, belong to the Rockhampton (Gympie) Beds.

Mr. Daintree also refers‡ to the Broken River as one of the localities from which he obtained *Lepidodendron australe*, McCoy. It may be surmised the *Lepidodendron* Beds occur in a horizon equivalent to that of the Star Beds, and separable from the strata which have yielded the Corals described by Prof. H. A. Nicholson and my Colleague (Burdekin Beds).

In the valley of Machine Creek, on the eastern side of the quartzites and shales (of undetermined age) which, together with intrusive diorites, form the country-rock of the auriferous reefs of Commissioner's Hill, a considerable thickness of conglomerates and grits and greenish-grey and purple sandstones and shales are met with, the sandstones containing *Lepidodendron australe*, McCoy. These beds are seen in two places—the first south of the Gilberton Township, and the second at the head of Star Gully—to overlie the quartzites and shales unconformably, but are faulted against them elsewhere, so far as the boundary has been traced. There can be little doubt that these beds belong to the Star Formation.

From the Northern area, which may be considered as the type district of the Star Formation (including Star, Keelbottom, Harvest Home, and Mount Wyatt), the following fossils have been derived, as per my Colleague's revised list:—

*Lepidodendron australe*, McCoy.

„ *sp. ind.*, Pl. 6, figs. 1, 4.

*Cyclostigma*, *sp.*, Feist., allied to *C. Kiltorkense*.

*Actinocrinus*, *sp. ind.*, Pl. 7, fig. 9.

*Beyrichia varicosa*, T. R. Jones, Pl. 7, fig. 15.

*Phillipsia dubia*, Eth., Pl. 7, fig. 12; Pl. 8, figs. 5, 6; Pl. 44, fig. 4.

*Fenestella multiporata*, De Kon., Pl. 8, figs. 7, 8.

*Spirifera bicarinata*, Eth. fil., Pl. 10, figs. 9, 13; Pl. 37, fig. 17; Pl. 11, figs. 1-3.

*Spiriferina duodecemcostata*, McCoy, Pl. 44, fig. 12.

*Reticularia Urei*, Fleming.

*Retzia radialis*, Phill., Pl. 11, figs. 24, 25.

*Rhynchonella pleurodon*, Phill., Pl. 11, fig. 23.

*Ortho resupinata*, Martin, Pl. 11, figs. 26, 28.

*Strophomena rhomboidalis*, var. *analogia*, Phill., Pl. 12, figs. 8, 9; Pl. 40, fig. 6.

*Chonetes cracowensis*, Eth., Pl. 13, fig. 9.

\* Daintree, General Report upon the Northern District. Brisbane: by Authority: 1870, p. 7.

† Quart. Journ. Geol. Soc. (1872), xxviii., p. 289.

‡ Loc. cit.

*Chonetes*, *sp. ind.* (a), Pl. 13, fig. 10; Pl. 37, figs. 21, 22.

„ *sp. ind.* (c), Pl. 37, fig. 20.

*Entolium*, *sp.*

*Euchondria*, *sp.*

*Nucula*, *sp. ind.*, Pl. 40, fig. 10.

*Nuculana*, *sp. ind.*, Pl. 14, fig. 17.

*Naticopsis variata*, Phill.?

„ *sp. ind.*

*Porcellia Pearsi*, Eth. fil., Pl. 15, figs. 7, 8.

*Orthoceras*, *sp.*

Palæoniscid Fish.

From the Drummond Range a number of fossils have been obtained by the late Rev. J. E. Tenison Woods, Mr. W. Fryar, Mr. A. E. Holmes, Mr. C. T. Musson, and the late Mr. James Smith, which enable us to place the strata in which they occur on the horizon of the Star Beds. The strata of the Drummond Range, of which the cuttings on the Central Railway afford admirable sections, do not bear any strong resemblance to the Star Beds of the Northern areas. Three miles and a-half east of Pine Hill Station (248½-mile peg) yellow gritty sandstones and shales are seen dipping at 7° to W.—a dip which would carry them beneath the Desert Sandstone. At 243 miles similar sandstones dip to S. at 12°. From Hannam's Gap (235 miles) to Bogantungan (227 miles) the strata consist of finely laminated, fine-grained, blue-grey sandstone, and blue, grey, and greenish, and occasionally purple, shales. Thick beds of hard gritty white, yellow, or brown siliceous sandstone occur at intervals. From Hannam's Gap to Bogantungan the strata dip at an average angle of about 2° to E. (a little steeper than the grade of the railway). At Bogantungan is the axis of a synclinal trough, and as far eastward as Withersfield the dip is towards the west. The total thickness of the strata is probably not less than 2,000 feet. According to the railway survey Pine Hill Station is 1,158 feet; Drummond (241 miles), 1,450 feet; Hannam's Gap, 1,717 feet; Bogantungan, 1,098 feet; and Withersfield, 834 feet above the sea-level.

Early in 1890 (?) Mr. C. T. Musson, F.L.S., presented to the Mining and Geological Museum, Sydney, numerous pieces of greenish-grey sandy micaceous shale, with small fish scales and plates scattered over them, from a locality in the Drummond Range which he described as follows:—

“On and around a small ridge, half-a-mile from and to the north of the Bogantungan Railway Station, I found numerous fish-remains consisting of scales and spines in nodules from what appear to be Carboniferous shales, the beds dipping east, and apparently continuous with those of a similar character developed at the east end of the cutting in the range, some two or three miles away. The fossils occur in nodules, which are seen to rest in thin bands in a section showing hard and soft beds of a peculiar dark-greenish clay (mapped Carboniferous by the Geological Survey), with other harder bands in thin layers, which are sometimes seen to cap the ridges. The fossils were found *in situ*, and lying about the gullies, of which there are three. The beds rest on a coarse gritty rock in places of a crystalline character. The hard fossiliferous bands vary considerably in themselves, and show evidence of having been altered from their original condition.”\*

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\* “Note on the Occurrence of Fish Remains in the Rocks of the Drummond Range, Central Queensland.” By R. Etheridge, Junr. *Records Geol. Survey New South Wales*, Vol. ii., Pt. 2, 1890, p. 72.



Of these remains Mr. Etheridge says \*: "On examining the scales and other plates they struck me at once as those of a Palæoniscid, but before finally adopting this view I forwarded drawings to Mr. A. S. Woodward, of the British Museum, who confirmed it."

Mr. James Smith, having been sent to collect from this locality, made a report dated 23rd March, 1891—the last received from him—which, though tinged with the pardonable exaltation of an enthusiastic naturalist, is as full of shrewd observation as any of his earlier writings, and may be quoted in full as practically his "last words" to the scientific world. On 4th April Mr. Smith returned to Rockhampton from a collecting trip to Springsure, suffering from the effects of exposure and repeated wettings, and on 10th April expired.

"The mud shales [of the Drummond Range] are very susceptible to decomposition. The action of the atmosphere crumbles them rapidly back into the dust from which they came. They are eaten out from between the sandstone beds, which, left without support, topple down and encumber the slopes of the hills, showing to advantage the process of denudation. Or they stretch along for miles in overhanging cliffs, giving variety to the view. By this process glens and gorges a thousand feet deep have been excavated, forming the magnificent landscapes of the Drummond Range.

"The numerous railway cuttings, some of them forty feet deep, afford splendid sections for studying the character of the formation. I made sixty traverses, on foot and by rail, of these cuttings, and adjacent creeks and gullies; examined all the spill-banks and rock-shelves. After the most careful observations I could see no sign of any organism, *in any of the shales*.

"It is in and on the sandstones the harvests of the collector's treasures can be gathered—an abundant land flora, a still more abundant marine fauna.

"The plant-remains are *Cyclostigma*, *Lepidodendron*, and *Calamites* of various kinds, beautifully marked, fluted, and grooved. These have been determined in the Rev. Mr. Tenison Woods' work on the 'Fossil Flora of the Coal Deposits of Australia,' and they are in great abundance. In every spill-bank, in every creek, they are printed on and in the rocks, in promiscuous confusion, as if wafted to a shore and sanded up, or water-logged and sinking to the bottom.

"Then there is the great fish-bed. A band of fine-grained, finely stratified, grey sandstone, twelve inches thick—the lowest band of the cutting at Hannam's Gap. This band has been excavated, and cast aside on spill-banks, on both sides of the railway. The centre of the band is black, and has the appearance of anthracite, derived, I believe, from the matter of the fishes' bodies. The scales in this centre part are very black and glistening, the bones merely black films. The action of the air has left this middle part all gaping open in parallel fissures. It is on both sides of this centre band, throughout the rest of the body of the stone, that the fish-remains are in better preservation. They consist of bones, scales, spines, and fins, in marvellous abundance. Among the fins are heterocercal fish-tails. There are also oolitic structures, which I suggest may be the spawn of fishes. Although there are some curved bones, like retractile teeth, two inches long and half-an-inch thick at the base, yet upon the whole I think the fishes were of small size; the fins are only a little longer than those of a haddock. The rhomboid scales, with comma-like attachment, are beautifully wrinkled. The triangular ones are deeply serrated on the sides and wrinkled on the back, while the 'oat-shaped' (*Eth. Junr.*) ones have a short groove in

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\* *Loc. cit.*

the back, for the overlapping point of the next one to lie in. Do these three different sets of scales indicate different fishes of the same family?

"One thing the specimens will prove. They must have been in most incredible numbers, like a herring shoal, in length, breadth, and thickness. Outcrops of the known bed are found nine miles apart. The width has not yet been ascertained.

"My instructions were to look out for and collect fish-remains. Unfortunately you cannot bag a spill-bank, nor can a railway train carry it away. It will be a long day hence before all the fish-remains of the Drummond Range are in museums. I brought away eight bushels.

"I did not see any of the crystalline rocks *in situ* mentioned by Mr. Musson, although there are plenty of water-worn crystalline boulders, in the alluvium of the Bogantungan Creek banks. I prefer to believe these are from some dyke in the upper ranges, for on going two miles lower down the creek, at a much lower level, the indurated stratified ferruginous lower sandstone bed still rests on stratified shales. It was here I found the largest Calamite *in situ*, and they are found in all the sandstone beds up to the summit, showing a long period of growing somewhere, and then being carried to the point of deposition in the sandstone-forming beds.

"There is a thin band of limy marl runs along for miles, near the bottom of all the cuttings. There are numerous hand-size crystallised septaria concretions, of which I secured specimens. At the 237-mile the sandstones are splendid slabs, four to five feet square, enough to pave a city—hard and indurated, recalling memories of the Arbroath slabs (Lyell's Elements, p. 403)."

These fish-remains form an additional and strong link connecting the Drummond and Star Beds. Mr. Smith's fossils have not yet been examined.

My Colleague's revised List of Fossils from the Drummond Range is as follows:—

*Calamites varians*, Germar.

*Asterocalamites scrobiculatus*, Schloth.

*Ancimites austrina*, Eth. fil.

*Lepidodendron australe*, McCoy.

„ *veltheimianum*, Sternb.

„ *sp. ind.*, Pl. 6, figs. 1, 4.

*Cyclostigma australe*, Feist.?

*Stigmara*, *sp. ind.*, Ten. Woods.

*Cordaites australis*, McCoy?

Palæoniscid Fish Remains.

It will be seen that, up to the present time, the Drummond Beds have yielded a longer list of plants than the Star, while on the other hand the Star Beds have a considerable number of marine organisms which are not represented, so far as we know, in the Drummond Range, with the exception of Palæoniscid fish, which are common to both.

At Elgin Downs, sixty-five miles east of Clermont, Mr. Rogers-Harrison obtained *Lepidodendron*, *Calamites* (?), and what was "probably the fruit of a conifer." \* There is no information available with regard to the strata from which these plant-remains came, but it is not improbable that they are the equivalents of the Star or Drummond Beds.

Grouping the whole of the above localities together, including the Star proper, Keelbottom, Harvest Home, Mount Wyatt, Canoona, Broken River, and the Drummond

\* Report on the Geology, &c., of the Country in the Vicinity of Clermont. By W. H. Rands. Brisbane: by Authority: 1886, p. 3.

Range, under the head of the "Star Beds," the complete list of fossils, as revised by my Colleague, is as follows:—

*Calamites varians*, Germar.  
*Asterocalamites scrobiculatus*, Schloth.  
*Aneimites austrina*, Eth. fil.  
*Lepidodendron australe*, McCoy.  
     " *veltheimianum*, Sternb.  
     " *sp. ind.*, Pl. 6, figs. 1, 4.  
*Cyclostigma australe*, Feist. ?  
     " *sp.*, Feist., allied to *C. Kiltorkense*.  
*Stigmara*, *sp. ind.*, Ten. Woods.  
*Cordaite australis*, McCoy.  
*Actinocrinus*, *sp. ind.*, Pl. 7, f. 9.  
*Beyrichia varicosa*, T. R. Jones.  
*Phillipsia dubia*, Eth.  
*Fenestella multiporata*, De Kon.  
*Spirifera bicarinata*, Eth. fil.  
*Spiriferina*, *sp. ind.*

*Reticularia Urei*, Fleming.  
*Retzia radialis*, Phill.  
*Rhynchonella pleurodon*, Phill.  
*Orthis resupinata*, Martin.  
*Strophomena rhomboidalis*, var. *analoga*, Phill.  
*Chonetes cracowensis*, Eth.  
     " *sp. ind. (a)*, Pl. 13, f. 10.  
     " *sp. ind. (c)*, Pl. 37, f. 20.  
*Entolium*, *sp.*  
*Euchondria*, *sp.*  
*Nuculana*, *sp. ind.*, Pl. 14, f. 17.  
*Naticopsis variata*, Phill. ?  
     " *sp. ind.*  
*Porcellia Pearsi*, Eth. fil.  
*Orthoceras*, *sp.*  
*Palæoniscid* Fish.

Of the above fossils, *Lepidodendron australe*, *Cordaite australis*, *Actinocrinus*, *sp. ind.*, *Phillipsia dubia*, *Spirifera bicarinata*, *Rhynchonella pleurodon*, *Orthis resupinata*, and *Strophomena rhomboidalis*, var. *analoga*, are common to the Star and Gympie Formations; *Chonetes cracowensis*, *Porcellia Pearsi*, and *Orthoceras* are common to the Star and Gympie Formations and the Middle Series of the Bowen River Coal Field; the remainder, viz., *Calamites varians*, *Asterocalamites scrobiculatus*, *Aneimites austrina*, *Lepidodendron veltheimianum*, *L. sp. ind.* (Pl. 6, figs. 1, 4), *Cyclostigma australe* ? *C. sp. all. to C. Kiltorkense*, *Stigmara*, *sp. ind.*, *Beyrichia varicosa*, *Fenestella multiporata*, *Spiriferina*, *sp. ind.*, *Reticularia Urei*, *Retzia radialis*, *Chonetes*, *sp. ind. (a)*, *Chonetes*, *sp. ind. (c)*, *Entolium*, *sp.*, *Euchondria*, *sp.*, *Nuculana*, *sp. ind.*, *Naticopsis variata*, *Naticopsis*, *sp. ind.*, and the Palæoniscid Fish, are peculiar to the Star Beds.

The Star Beds have not a single species, so far as we yet know, common to the (Middle Devonian) Burdekin Beds.

Comparing the genera represented in the Star Beds with those of the other members of the Permo-Carboniferous System, we find that, among Plants, *Calamites*, *Lepidodendron*, and *Cordaite* are also present in the Gympie Formation. Among Crinoids, *Actinocrinus*, and among Crustaceans, *Phillipsia*, are common to both. Among Polyzoa, *Fenestella* is present in both. Lastly, the two formations have nine genera of Mollusca in common—viz., *Spirifera*, *Reticularia*, *Retzia*, *Rhynchonella*, *Orthis*, *Strophomena*, *Chonetes*, *Naticopsis*, and *Porcellia*.

Common to the Star and Middle Bowen Formations are one genus of Polyzoa, viz., *Fenestella*, and five of Mollusca, viz., *Spirifera*, *Spiriferina*, *Chonetes*, *Porcellia*, and *Orthoceras*.

There are not even any genera common to the Star and Upper Bowen Formations.

The late Mr. C. S. Wilkinson, Government Geologist for New South Wales, in "Mines and Mineral Statistics of New South Wales, 1875,"\* observed that "Below the lower marine beds of the Hunter district are beds of shales and sandstones,

with several species of *Cyclopteris*, *Knorria*, *Sigillaria*, *Stigmaria*, *Lepidodendron*, &c. . . . . They occur near to, and probably in association with, beds of marine fossils which have been described as lower carboniferous." These beds, which are particularly well developed in the neighbourhood of Stroud, I believe to be on the same horizon as the Star Formation; but no passage has ever been observed in New South Wales from the *Lepidodendron* Beds referred to, upwards into the marine beds of the Hunter district.

In his "Notes on the Geology of New South Wales,"\* Mr. Wilkinson says:—"Near Canowindra, on the Lachlan River, are ranges composed of purple and white sandstones and shales containing *Lepidodendron* and *Sigillaria*. The Weddin Mountains and those conspicuous hills beyond Condobolin consist of similar rocks, which may also belong to this age, or to the Upper Devonian, but as yet no fossils have been found in them. The lower beds are extensively developed between the Hunter and the Manning Rivers, where they form high broken ranges. They consist of conglomerates, sandstones, limestones, and shales, which have been much disturbed, being tilted at all angles. Near Gloucester there is a splendid natural section showing, for a distance of more than a mile, the beds in a vertical position. Though plant-remains are abundant in these rocks, no workable coal-seams are known. This is somewhat remarkable, seeing that the fossils are of the genera which are characteristic of the great Coal Measures of England—viz., *Lepidodendron*, *Sigillaria*, and *Oulamites*. The gold-bearing quartz reefs yielding from 1 to 15 oz. of gold per ton, now being worked on the Copeland Gold Field, traverse strata containing these fossils.† There are other beds in the same series rich in marine fossils—*Productus*, *Spirifer*, *Crinoids*, *Fenestella*, &c."

It is possible that the Avon River *Lepidodendron* Beds, Victoria, may be approximately on the horizon of the Star Formation.

J.

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\* Sydney: Government Printer: 1882.

† So far as the fossils show, these beds may be equivalent to our Gympie Beds.

## CHAPTER XI.

### THE PERMO-CARBONIFEROUS SYSTEM—*continued*.

#### THE BOWEN RIVER COAL FIELD

##### AND ITS SUBDIVISIONS.

THE Coalfield, which extends from the Bowen River in Lat.  $20^{\circ} 30'$  southward to the heads of the Dawson in Lat.  $26^{\circ}$ , is capable of subdivision into three distinct formations: a Lower, in which no organic remains have as yet been discovered, and which is, in the Mackay District, considerably altered, and in the Bowen River is divided from the succeeding formation by a series of bedded volcanic rocks; a Middle, rich in organic remains, chiefly of marine origin, but with an admixture of the remains of a terrestrial vegetation; and finally an Upper, full of the remains of a land vegetation (of which one genus at least, viz., *Glossopteris*, is common to the Middle Formation), but with at least one intercalated bed in which characteristic species of the marine fauna of the Middle Formation reappear. The three formations form a continuous series.

Following Daintree, I divided, in my Geological Map of the Colony issued in 1886, the Bowen River Coal Field from the Coal Field of the Isaacs, Mackenzie, and Dawson lying to the south; Daintree's Map, issued in 1872, showing an extension of the basaltic area of Peak Downs, to the north-west and north of the latter field. Since then, however, Mr. Maitland has examined the intervening district,\* and shown that the Bowen and Mackenzie Coal Fields are in reality continuous, although covered, at the heads of the Bowen, Suttor, and Isaacs Rivers, by outlying tablelands of the Desert Sandstone.

In my Geological Map (1886), the whole of the Mackenzie Coal Field was ascribed to the Upper Formation, as it had never been examined in detail. The Geological Map issued herewith, however, shows that the Upper Formation is flanked to east and west by members of the Middle Formation—an alteration which is justified by Mr. Maitland's and my own work in the field in the neighbourhood of Nebo, by Mr. Rands' observations in the Clermont District, by Mr. Smith's discoveries of characteristic "Middle" fossils at Springsure and Banana Creek, and by Mr. Daintree's recorded observations at Cracow Creek. In the southern portion of this district, however, no detailed mapping has ever been done, and the dividing line between the Middle and Upper Formations has not been traced, and consequently cannot be supposed to have been laid down accurately on the map.

In the year 1878 I made a detailed survey of the Bowen River Coal Field,† separating, for the first time, the Lower, Middle, and Upper Formations. A description of these subdivisions is given in the succeeding chapters.

J.

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\* Report on Geological Observations at the Heads of the Isaacs, the Suttor, and the Bowen Rivers  
Brisbane: by Authority: 1889; and Annual Progress Report of the Geological Survey for 1889  
Brisbane: by Authority: 1890.

† Report on the Bowen River Coal Field. Brisbane: by Authority: 1879.

## CHAPTER XII.

### THE PERMO-CARBONIFEROUS SYSTEM—*continued*.

#### THE LOWER BOWEN FORMATION IN THE TYPE DISTRICT.

IN the district from which this series receives its name, and in which it was first mapped, the granite, schists, slates, and other plutonic and metamorphic rocks of the Clarke Range are succeeded by a thick accumulation of coarse volcanic agglomerate, made up of angular or but little rounded pebbles and boulders. On this agglomerate lie thick beds of conglomerate, the pebbles of which are mainly of quartzite and yellow porphyry derived from the surrounding metamorphic country, but a few are of porphyrite, &c., derived from the immediately underlying bed of volcanic agglomerate. To the conglomerate succeeds a mass of yellow siliceous sandstone, at least fifty feet in thickness and probably much more. Soft stratified rocks of a similar character evidently crop out all over the plain which extends southward from a little mountain about three miles below the head of Pelican Creek to Mount Devlin, under whose steep escarpment they dip and disappear. As the breadth of this flat is about a mile, a dip of  $10^{\circ}$  would give a thickness of about eight hundred and eighty feet.

The Bowen and Sonoma Road, between Bolger's (ruined) Public-house and Strathmore Creek, crosses the outcrops of several beds of white and yellow sandstones, dipping at a low angle to the south-east. This dip would carry the sandstones beneath the porphyrites, which are first met with near Strathmore Creek, and which presently rise in terraces in the Mount Toussaint Range. From their position, resting on the metamorphic rocks and underlying the bedded traps, there can be no doubt that the sandstone beds in question are the equivalents of those which, at the head of Pelican Creek, dip under the traps of Mount Devlin.

#### INTERBEDDED PORPHYRITES AND BASALTS.

The volcanic range of Mount Toussaint and Mount Devlin presents the usual features characteristic of slightly inclined trappean rocks. The range appears very different according as it is viewed from the "dip" or "rise" side of the beds. In the one case the long gentle slope of the hill generally coincides with the surface of a bed. In the other the ascent must be made over a series of alternate terraces and almost perpendicular cliffs.

Over considerable areas basalts and melaphyres decompose to a rich black soil. The amygdaloidal porphyrites form a lighter but still very good soil.

The terraced and scarped hills of the Mount Macedon Range continue the outcrop of the bedded trap round the north-western corner of the coalfield.

It is difficult to find, either in the Mount Macedon or Toussaint Range, a hand specimen of the trappean rock which has not obviously undergone considerable alteration. A specimen from the south end of Mount Macedon, which appeared more than usually fresh, was sliced and examined microscopically. The ground-mass showed a tangled web of very minute interlacing crystals of labradorite, the interstices filled up with specks of magnetic iron. The augite crystals were generally represented by a zeolitic pseudomorph (prehnite?), although occasionally a nucleus of augite could be

detected in the centre of an altered mass. The rock was thus, in all likelihood, originally a typical dolerite. It is not surprising that igneous rocks so ancient should have undergone much alteration.

On Strathmore Creek, on Pelican Creek from Mount Bellavista downwards, and in the Bowen River at the north end of the coalfield, the rock is exceedingly amygdaloidal, and is full of cavities, sometimes of considerable size, filled up with prehnite, thomsonite, analcime, or laumontite. With the prehnite, carbonate of copper is frequently associated, some specimens of the ore being quite good enough to work if sufficient quantities could be obtained. The ore, however, so far as I was able to see or learn, nowhere occurs in lodes.

Mr. Samuel Allport, F.G.S., thus reports\* on the microscopic aspect of "Epidote rock" from the "Bowen River, near McDougal's head station" (Birallee, now Mr. Hughes's):—

"It must have been originally as scoriaceous as any recent lavas, but now forms a hard solid mass of zeolitic mineral matter. All the cavities are filled with prehnite in radiating groups of crystals, which exhibit a magnificent display of colours when examined in polarised light. One cavity is lined with the radiating prehnite, and the central portion partly filled with calcite and partly with carbonate of copper. Of the original constituents nothing is left except the magnetite. The forms of felspar crystals are sharp and distinct; but the original substance has been removed and replaced by prehnite, differing in no respect from that filling the cavities. The reddish-brown grains and patches scattered through the base probably represent the augite."

In the Mount Toussaint and Mount Macedon Ranges, as well as in the bed of the Bowen River and Pelican Creek, geodes of opal, agate, and chalcedony are not unfrequently met with.

J.

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\* Quart. Journ. Geol. Soc., xxxviii., p. 315.

## CHAPTER XIII.

### THE PERMO-CARBONIFEROUS SYSTEM—*continued*.

#### THE LOWER BOWEN FORMATION OUTSIDE OF THE TYPE DISTRICT—MACKAY DISTRICT.

THE interbedded basalts, &c., between the Middle and Lower Series are not seen along the junction line south of the heads of the Bowen River, so that it appears that a fault, which further north throws the basalts, &c., against the metamorphic rocks, to the south throws the Middle down against the Lower Series.

The Lower Formation in the coast region, although possessing many of the characteristics of the same series in the district north of the Bowen River Coal Field, is much better developed and occupies a much larger extent of country. Owing to the intrusion of volcanic rocks no trustworthy estimate of its thickness can be made, but making allowance for all contingencies the thickness is probably not less than 1,000 feet.

At Mount De Moleyn on the north bank of the Pioneer River, west of Mackay, the Lower Series rests upon a coarse volcanic agglomerate resembling that which occurs at the head of Pelican Creek. South of the Pioneer River, the Lower Series attains a great thickness, and has been penetrated by granites, dolerites, and basalts, which in many cases alter the strata in contact with them for a considerable distance. At the heads of the Pioneer a gradual passage from a comparatively unaltered sandstone into a granite can be observed; in no case, however, has the metamorphism gone so far as to entirely mask the clastic character of the rock.

"It is a noteworthy circumstance that it is in this, the lowest member of the series, that the greatest amount of metamorphism has taken place. Indeed no section was seen in which it could be confidently asserted that the granitic rocks penetrate the higher members of the series." Mr. Maitland observes that this circumstance may indicate that a sufficient time elapsed to allow of the metamorphism of portions of the Lower Series before the Middle Series was deposited.

In the area drained by Rocky Dam Creek, south-west of Mount Funnel, the rocks of the Lower Series have undergone much alteration, some of the grits assuming the appearance of quartz-felsites, whilst some sandstones have been altered into quartzites. North of Mount Funnel horizontal beds of conglomerate and sandstone, of various degrees of colour and texture, are exposed in several gullies; near Mount Selwyn one bed is a green felspathic conglomerate, in which clear and pellucid blebs of quartz appear to have been developed subsequent to its deposition.

Where the St. Lawrence Road crosses Rocky Dam Creek a bed of coarse grit is seen, dipping at a low angle to the east. Further up the creek, on its southern bank, in Selection 1442, is a low hill of dolerite, probably intrusive through the sedimentary rocks. In the bed of the creek, higher up, an altered sandstone is seen, and on a mountain bearing 52° 50' from Mount Funnel, the seaward face consists of a great thickness of an altered conglomerate, penetrated by a dyke of felsite.

A spur on the western face of Cone Mountain is made up of a massive quartzite, apparently horizontal. From this point, in a traverse northward across Rocky Dam and Arrowroot Creeks to the Eildon Hills, altered sandstone and shales are seen at intervals.



On one of the branches of Cherry-tree Creek, flowing through Selection 1531, a baked black shale is seen dipping E.S.E. at  $35^{\circ}$ , and what appears to be a volcanic breccia is visible close to the great mass of rock mapped as diorite, which occupies a considerable area of country close to the St. Lawrence Road.

In the bed of Cherry-tree Creek, about three-quarters of a mile north-east of the house in Selection 1569, a mass of felsite has been protruded through reddish-brown shales and conglomerates, spreading out over the surface of the conglomerate. Both the conglomerate and the underlying shales have been altered by the felsite. Higher up the creek is a great thickness of conglomerate, very coarse-grained at the base but finer above. In the upper portion of the conglomerate, much felspar, a little quartz, and some iron pyrites have been developed in the mass. A dyke of felsite intersects the conglomerate. Near the head of the creek an intrusive mass of granite forms the summit of the range.

Between Cherry-tree and Plum-tree Creeks the prevailing rocks consist of altered grits, conglomerates, and sandstones, in horizontal beds. A felsite dyke intersects the stratified rocks, in which, near the dyke, secondary crystals and crystalline grains of quartz are developed.

In Alligator Creek, one of the heads of Atherton's Creek, a mass of sedimentary rocks, with a contemporaneous sheet of diorite, are pierced by protrusions of felsitic rocks, as sketched in Plate 53, fig. 1. From the base of the felsite sheet to the top of the grit forming the summit of the range is two hundred and sixty feet.

In Bell's Creek, a branch of Atherton's Creek, the section sketched in Plate 53, fig. 2, is seen. On a thick series of grits and shales which dip W.S.W. at from  $15^{\circ}$  to  $20^{\circ}$ , lies an intrusive (?) sheet of a porphyritic felsite. Above the felsite are greyish-yellow shales and sandstones, one bed of shale being crowded with imperfectly preserved plant-remains. An intrusive boss of diorite is erupted through the sedimentary rocks and felsite, altering the shales into lydian-stone and the grits into quartzite. Above the greyish-yellow shale and sandstone are dark shales and grits, dipping to S.S.W. at  $10^{\circ}$ . Through these rocks a sheet of felsite has been intruded along the planes of bedding. This sheet is doubtless connected with a vertical dyke of a similar rock seen a little higher up the creek. About 1,000 feet above the lowest beds of the section a mass of felsite, twelve or fourteen feet thick, has been intruded along the bedding planes of the shales and sandstones. Above the felsite are shales and sandstones up to the summit of the range.

In a gully, a tributary of Sandy Creek, behind Oakenden Plantation, a granitic dyke, somewhat similar in character to the granite of the Mount Bridgman Range, penetrates shales and sandstones, indurating the former and converting the latter into quartzite.

In a creek parallel to the last and also running into Sandy Creek, shales and altered grits, dipping at  $15^{\circ}$  to S.W., are accompanied by sheets of basalt, apparently intrusive, the basalt and stratified rocks both penetrated by a granitic dyke.

Near Homebush Hill, altered shales and sandstones penetrated by a dyke of quartz-felsite occur. Remains of reed-like plants and fragments of silicified wood are common, but too indistinct for determination. In a creek crossing the boundary of Portions 775 and 1603, sandy shales, dipping at  $20^{\circ}$  to  $25^{\circ}$  to E.N.E., are interrupted by a sheet of felspar porphyry. At Selection 1380, sandstones and shales are seen in a gully, the former containing fragments of silicified wood and the latter plant-remains.

One of the branches of Cut Creek shows alternations of sandstones and shales with intrusive diorite; following up the gully until, due east of Mount McBride, a horizontal bed of altered conglomerate is seen.

*Pioneer River.*—The country drained by the Pioneer River and its tributaries is rudely triangular in shape, and of about six hundred square miles in extent, but by far the greater portion is occupied by crystalline rocks and alluvial soil. It is only here and there that any sedimentary rocks are seen.

In the bed of the Pioneer, near Dumbleton, is an exposure of intensely metamorphosed sandstones, grits, and shales, with intrusive dykes of basalt and diorite. Higher up the river, below the bridge at Pleystowe Mill, is a series of black shales showing little or no alteration beyond a slight increase in hardness within a couple of inches of a dyke of diorite-porphyrityte with which the rocks are associated.

In the hills to the south of Ashburton Mill, sandstones and shales dip W. at  $25^{\circ}$  to  $30^{\circ}$ , and a bed of volcanic ash occurs among the sedimentary rocks.

In the hills between Ashburton and the Bowen Road, black, slightly indurated shales dip at  $15^{\circ}$  to E.N.E. Black Waterholes Creek rises in a deep, scrubby gorge, whose sides show sections of coarse altered sandstones and grits, below which black sandy shales are seen to dip to E. at an angle of  $10^{\circ}$ . One of the main tributaries of Black Waterholes Creek shows a quartzite underlaid by a very hard lydianised shale lying horizontally. Further up the creek, in Selections 1602 and 1414, the rocks are pierced by an intrusive granite. Lower down the creek, greyish sandstones and black shales dip at  $15^{\circ}$  to W.

Several other tributaries of the Pioneer show sandstones and grits, all more or less metamorphosed, so much so in some places that, in the absence of "bedding-planes," ripple-marks, &c., they might easily be mistaken for some forms of granite.

On the spurs of the Main Range, between Cattle Creek and a tributary named Dalrymple Creek, the gradual passage from a comparatively unaltered grit into a granite can be satisfactorily traced. Starting with a grit showing distinct traces of bedding, a quartzite is next seen, passing in turn into what appears to be a porphyritic felsite, and ending in a true granite. Several similar instances can be seen in this area. A noteworthy case occurs near Snake Hill, on the divide between the waters of Black's Creek and Stockyard Creek. Here a micaceous sandstone merges almost insensibly into a medium-grained granite.

At several places along the slopes of the hills on the southern banks of the Pioneer, near the Blue Mountains, horizontal sandstones and shales are interstratified with lavas and ashes.

In the Parish of Bong Bong, opposite Selection 1221, a bed of fine-grained diorite overlies a horizontal bed of grit. Farther up the hill a bed of volcanic ash, composed of subangular fragments of rock, rests on the diorite.

In the bed of Constant Creek, below Selection 756, a bed of black shale, dipping S.S.W. at  $10^{\circ}$ , contains three bands of fireclay, varying from one to four inches in thickness. These have often imbedded among them flat circular concretionary siliceous nodules. In Selection 1358 the shales are vertical and are faulted against a fine-grained sandstone. In the Township Reserve, east of Mount Jukes, sandstones and shales, with an intrusive orthoclase porphyry, dip at  $20^{\circ}$  to N.W. Constant Creek rises in the Mount Toby Range, and flows over alternations of grit and shale, which here roll about a good deal, and are well seen in the Bowen Road, between the Leap and Jolimont Station.

Murray Creek rises in one of the spurs of Mount Dalrymple, and drains an area mainly composed of crystalline rocks. The only tributary it receives whose waters flow over sedimentary rocks is Jolimont Creek.

On one of the branches of Jolimont Creek, behind the Beaumont Store, are black shales, with one or two highly carbonaceous bands, semi-vitreous white sandstones,

and massive fine-grained sandstone slightly indurated. A sheet of intrusive felsite occurs in the black shales and semi-vitreous sandstones. The whole series rests on diorite. In the bed of the creek, below the store, a sheet of diorite is seen overlying a bed of argillaceous shale.

At the foot of Mount Roy, on the western bank of Jolimont Creek, a white semi-vitreous grit rests on decomposed diorite, and is succeeded by a contemporaneous sheet of dolerite, ten feet in thickness. The dolerite is overlaid by a thick mass of white semi-vitreous sandstone, quartzose, conglomerate, and yellowish grit, the whole dipping at  $5^{\circ}$  to  $8^{\circ}$  N.W.

An outcrop of semi-vitreous sandstone is seen near Palm-tree Creek, on the Bowen Road. Some portions of this rock appear as if a second deposition of quartz had taken place subsequent to its formation. The sandstone rests on a volcanic ash or fine agglomerate.

In a quarry further north along the Bowen Road a contemporaneous sheet of diorite, two feet thick, weathering into spheroidal masses, is overlaid by beds of argillaceous shale which dip to S.E. at  $40^{\circ}$  beneath dioritic lava.

On the south bank of St. Helen's Creek, and about two miles from the road, the sedimentary rocks lie directly on an uneven surface of felspar porphyry. The escarpment of the stratiform rocks can be traced for a considerable distance, and is well seen where the creek cuts its way through a narrow gorge, whose flanks are made up of beds of semi-vitreous sandstone and coarse conglomerate dipping at  $5^{\circ}$  to W.

A low gap in a range between St. Helen's Head Station and Mount Barren is made up of grits and fine conglomerates dipping at  $55^{\circ}$  to N.  $50^{\circ}$  E.

In Black Rock Creek, near Selection 1450, a vertical seam of inferior coal, two feet three inches in thickness, is intruded into by a sheet of greyish diorite. The coal is overlaid by buff-coloured shales.

Sandstones, grits, and shales, with sheets of diorite and dolerite, are seen at intervals in the low hills between Black Rock and Alligator Creeks.

"The stratiform series of volcanic rocks upon the uneven surface of which some of the sedimentary series were laid down," says Mr. Maitland, "are best developed on the northern side of the Pioneer River, where they cover a considerable tract of country. In no place was their base seen, and consequently no estimate of their thickness could be made. The rocks forming the series are diorites and basalts, with breccias and agglomerates. Nowhere do these rocks form any conspicuous feature, occupying, as they do, the rounded knobs on the lower ground."\*

J.

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The greater part of the details given in this chapter are taken from Mr. A. Gibb Maitland's Report on the Mackay District. Brisbane: by Authority: 1889.

NOTE TO PAGE 21.—Since this page was in print, the Warden has reported (31st December, 1891) that, in his opinion, the Last Call Mine, Cloncurry, must have been "salted."

## CHAPTER XIV.

### THE PERMO-CARBONIFEROUS SYSTEM—*continued*.

#### THE MIDDLE BOWEN FORMATION IN THE TYPE DISTRICT.

THE trappean rocks lying on the Lower Formation have been covered by sedimentary rocks, and the sedimentary and igneous rocks have been disturbed from their original horizontal position at the same time and in the same degree. The activity of the volcanic forces must have been considerably diminished, as neither lava-form nor ashy beds occur higher in the series. But that the volcanic activity did not cease for a long time is proved by the fact that molten rocks of the dolerite type were again and again injected along lines of weakness in the sedimentary rocks.

Following the right bank of the Bowen River from Biralee Station upwards, after traversing a basaltic plain for about three miles, a wall of white gritty sandstone, running N. 20° W. to S. 20° E., crosses the path. This sandstone is the lowest bed of the Middle Series. Its outcrop can be easily followed down the bank into the river, where the sandstone is seen to overlie, apparently without any break, a felspathic sandstone, which, in its turn, rests on the surface of a bed of porphyrite. The porphyrite and sandstone both dip E. 20° N. at a low angle. This is the only place where the base of the Middle Series is unequivocally visible. In other places—*e.g.*, Pelican Creek, Coral Creek, and the Bowen River two miles above Beasley's (ruined) Public-house—the sedimentary and igneous rocks may be observed in close juxtaposition; but there are reasons for believing them to be separated in these places by a line of fault, and that neither the highest members of the one series nor the lowest of the other are seen at the points of junction. About three miles above the old crossing at Beasley's, a sandstone bed crosses the Bowen River, dipping at 35° to S.W. This bed forms a conspicuous cliff known as "The Wall," which is traceable for miles to the south-east. It is evidently tilted by the fault which divides the coalfield from the metamorphic rocks to the north-east.

Up to a point midway between the mouths of Rosella and Parrot Creeks, the Marine Series occupies the bed of the Bowen River. After plotting the observed dips of the strata, I estimated the total thickness at 1,848 feet. It will be seen from the Geological Map that the area occupied by the Middle Series is much greater at the north-west end of the field than on the eastern side. This is accounted for by the comparatively high dip of the strata in the latter region.

The Middle Series is made up of alternations of grey and yellow sandstones and blue and grey shales, with here and there bands of reddish ferruginous, probably once calcareous, sandstones, sometimes varying to impure sandy ironstones. Two seams of coal (besides some carbonaceous beds hardly deserving the name of coal) occur in this series. These seams have been named the Garrick and the Kennedy. Other seams of coal have been met with in a bore to be afterwards referred to. Near the top of the series, black shales, highly impregnated with alum, are abundant.

A few beds of conglomerate are met with, chiefly in the lower part of the series. The pebbles are generally of granite, slate, schist, quartzite, and other metamorphic and

plutonic rocks, with a few of porphyrite. The pebbles, which are not always well rounded, have a remarkable tendency to arrange themselves in groups in some of the conglomeratic sandstone beds—a disposition which may possibly be owing to their having been dropped in heaps from the floating roots of trees, but much more likely to their having been dropped from floating ground-ice. Large isolated boulders of granite, &c., which could hardly have been brought to their present positions except by glacial action, occur here and there in the midst of strata of fine sandy or muddy material. Portions of the trunks of coniferous trees are occasionally found lying horizontally in the strata.

The bands of ferruginous sandstone are storehouses of marine fossils, which occur also, though more sparingly, in the shales and grey sandstones. In the latter the shells are almost always calcareous, and contrast strongly with the siliceous and felspathic sandstone matrix. In the ferruginous sandstones, on the other hand, the fossils are always in the form of casts. About fifty feet of pebbly sandstone strata on Stonehumpy Creek are absolutely crammed with shells, especially *Strophalosia Clarkei*, Eth. Another sandstone bed, at least one hundred feet thick, in the Bowen River, about two and a quarter miles above the old crossing at Beasley's, is also full of *Strophalosia Clarkei*. *Derbyia senilis*, Phillips, is abundant on Coral Creek; and on Pelican Creek, one mile above the Bowen and Sonoma Road, and near the Diamond Drill Bore. *Productus*, *Spirifera*, and *Martinia* are common throughout the whole series. The shales and grey sandstones are frequently pierced by rootlets in the position of growth. The marine shells prove that the strata were mainly deposited by a sea, of which the Clarke Range formed the eastern shore; while the upright rootlets in the grey sandstones and shales indicate the occasional appearance of land surfaces.

Near the base of the series, especially in Coral and Pelican Creeks near Sonoma Station, besides Mollusca of the usual types, Actinozoa and Polyzoa occur in great abundance. Of the former, *Stenopora Jackii*, Nich. and Eth. fil., is the most common. Of the latter, *Protoretetpora ampla*, Lonsd., *P. Koninckii*, Eth. junr., and *Fenestella fossula*, Lonsd., are all equally common. In one specimen in the Geological Survey Museum *Glossopteris* occurs in the same slab with *Protoretetpora ampla*. One bed in Pelican Creek half-a-mile above the road from Bowen to Sonoma, consisting of a sandy ferruginous limestone, is a mass of the coral *Stenopora Leichhardtii*, Nich. and Eth. fil. This fossil is remarkable for its brilliant red colour.

A large collection of fossils (Mollusca) from the Middle Series near Blenheim has been presented to the Geological Survey Museum by Mr. R. T. Barker, of Eungella. These still remain to be examined in detail.

About two hundred and seventy five feet above the base of the series is the Garrick Coal-seam, the outcrop of which is seen on Pelican Creek. Another seam, named the Kennedy, is believed to overlies the Garrick, but, as the two cliff-sections are not continuous, this cannot be stated with certainty.

In the bed of the river there can be seen in dry seasons the outcrop of a seam of coal about twenty feet beneath the outcrop of the Garrick Seam which is seen in the cliff above. The seam in the river may possibly be the Kennedy Seam, in which case there must be a fault, with a downthrow to the west, between the two cliffs containing the outcrops of the Kennedy and Garrick Seams. As the seam in the river was not met with in the bore, afterwards to be referred to, it must, if its place is below the Garrick Seam, either have thinned out in the half-mile which intervenes between the outcrop of the Garrick Seam and the bore, or its absence from the latter may be explained by a small fault.

The following is a section of the seam seen in the bed of the river:—

[illegible]

The coal has a specific gravity of 1·37 and is free of pyrites. It was used for the pumping engine attached to the bore. Its analysis is:—

Moisture ...	...	...	...	...	...	...	2.26
Volatile hydrocarbons ...	...	...	...	...	...	...	23.61
Fixed carbon ...	...	...	...	...	...	...	59.09
Ash ...	...	...	...	...	...	...	15.04

**100.00**

The section of the cliff showing the Kennedy Seam is as follows:—

	Ft.	in.
Soft white flaggy sandstones and shaly partings	27	0
Talus, concealing about	15	0
Dark-blue shales	5	0
Soft grey sandstone	0	9
Gritty white siliceous sandstone	2	8
Dark-blue shales	0	7
Coal	0	3
Dark-blue shales	0	1
Coal, Kennedy Seam	1	6
White fine-grained soft clayey sandstone, with upright rootlets	5	0
Soft yellow sandstone	2	0
Sandy shale	3	0
Soft yellowish sandstone	2	0
Shales, with a line of large ironstone nodules	8	0
White sandstone, in bands of about 8 inches thick	6	0
Shales...	1	0
Yellowish sandstone	5	0

The Kennedy Seam, as seen at its outcrop, is made up of fine laminae of varying purity and lustre, some of the laminae being mere carbonaceous clay, and others good coal. The coal burns with difficulty, leaving a scarcely diminished bulk of reddish shaly ash. It splits readily along the bedding-planes, and at right angles to these along numerous joints, and is very friable. It does not take a polish under the knife, but breaks up into minute cubes. The powder is ink-black. Its specific gravity is 1.463.

### ANALYSIS.

Water	... ..	1·12
Volatile hydrocarbons	... ..	41·81
Fixed carbon	} A bright, hard coke, 57·07 per cent.	42·79
Ash (light brown)		14·28

100.00

The cliff-section showing the Garrick Seam is as follows :—

	ft.	in.
Thick-bedded yellow sandstone, with <i>Edmondia</i> ... ..	10	0
Soft flaggy and shaly grey sandstone ... ..	20	0
Impure sandy ironstone, weathered ... ..	0	9
Soft fine-grained laminated grey shale, weathering yellowish ...	6	0
Coal, Garrick Seam ... ..	4	7
Soft grey shaly sandstone, with (sparse) rootlets ... ..	5	0

The Garrick Seam is seen in the cliff on the left bank of Pelican Creek. For about a third of this distance an intrusive sheet of "white trap" is seen cutting into the seam and rendering it locally useless, but the remainder of the outcrop is undisturbed.

The Garrick Seam at its outcrop, and where it is not burnt by the white trap, shows layers of shining coal alternating with layers of dark coaly shale. It burns with difficulty and leaves a good deal of brown ash. The joints are coated with sulphur and alum. The coal is moderately firm. It takes a feeble polish under the knife, with a deep black lustre. The powder is lamp-black. The specific gravity is 1.456.

## ANALYSIS.

Water	...	...	...	...	...	...	1.23
Volatile hydrocarbons	...	...	...	...	...	...	35.25
Fixed carbon	}	A bright, hard coke, 63.52 per cent.					46.60
Ash (grey)							16.92

100.00

Near the bottom of the seam a light, feebly lustrous, non-soiling coal occurs in nodules of three or four inches in diameter. They burn well. It would appear that in the formation of these concretions some of the earthy impurities have been rejected. Their specific gravity is 1.402. An analysis of one of these nodules gave—

Water	...	...	...	...	...	...	0.99
Volatile hydrocarbons	...	...	...	...	...	...	19.89
Fixed carbon	}	Spongy coke, very hard, 79.12 per cent.					67.58
Ash							11.54

100.00

A bore was sunk by the Government through the Garrick Seam to the base of the Middle Series in 1885. In company with Mr. Hester, the Engineer in charge of the bore, I examined the cores in August of that year, and compiled the following section. It is important as giving a continuous section of the lowest 339 feet of the Middle Series.

## SECTION OF NO. 1 BORE, PELICAN CREEK.

	Thickness.			Depth.	
	Ft.	In.		Ft.	In.
Loam and clay	...	...	...	4	0
Loose rock	...	...	...	4	0
Fine-grained buff micaceous sandstone (loose)—					
fissure and large opening at 25 feet	17	0	...	25	0
Fine-grained micaceous sandstone, buff, graduating					
downward into white (fissure)	44	0	...	69	0
Mud-seam, hardening downward into black					
micaceous shale (no core)	1	0	...	70	0
Fine-grained dark-grey micaceous sandstone, with					
plant-impressions	0	6	...	70	6
Dark sandy shale	0	6	...	71	0
Soft clay	0	1	...	71	1
Soft coal (no core)	1	0	...	72	1
Burnt coal (a)	1	6	...	73	7
Mixed white clay and pyrites	0	0½	...	73	7½
Burnt coal	2	4½	...	76	0
Fireclay (no core)	0	1	...	76	1
Fine-grained blue-grey micaceous sandstone, with					
streaks of carbonaceous shale	6	11	...	83	0
White gritty sandstone, with streaks of micaceous					
and carbonaceous shale	4	0	...	87	0

Garrick  
Seam.

## SECTION OF No. 1 BORE, PELICAN CREEK—continued.

	Thickness.			Depth.	
	Ft. in.			Ft. in.	
White sandstone, alternately fine and coarse grained, with bands of carbonaceous and micaceous shale	6	0	...	93	0
Blue shale, with layers of sandstone and streaks of carbonaceous shale	17	0	...	110	0
Very hard conglomerate	0	3	...	110	3
White freestone	4	9	...	115	0
Coaly streak	0	0½	...	115	0½
White freestone, with occasional carbonaceous films and plant-impressions	34	11½	...	150	0
Dark-blue carbonaceous shales, occasionally sandy	21	0	...	171	0
Gritty freestone (admirable scythestone), with a few carbonaceous streaks	10	0	...	181	0
Fine-grained grey shaly sandstone	4	0	...	185	0
Clay film	...	...	...	...	...
Burnt coal (a)	2	0	...	187	0
Clay	0	1	...	187	1
Coal (inflammable), no core, only small fragment preserved	1	0	...	188	1
Clay	0	1	...	188	2
Burnt coal (b)	2	9	...	190	11
White trap	0	8	...	191	7
Dolerite	0	8	...	192	3
Sandstone and conglomerate	0	6	...	192	9
Coal (c)	3	4	...	196	1
Fine-grained bluish-grey shaly sandstone	11	11	...	208	0
Coaly streak	...	...	...	...	...
Fine-grained bluish-grey shaly sandstone	8	0	...	216	0
Coal, good (according to Mr. Hester)—none saved	0	6	...	216	6
White gritty sandstone	34	6	...	251	0
Coarse gritty sandstone, occasionally pebbly, and with a few dark streaks	24	0	...	275	0
Alternate coarse and fine gritty sandstone, with a few dark streaks	11	0	...	286	0
Coal (bright and inflammable, according to Mr. Hester)—none saved	0	3	...	286	3
Dark-blue shale and burnt coal, occasionally shaly and full of pyrites (d)	2	3	...	288	6
White trap, passing downward into dolerite	0	6	...	289	0
Dolerite	5	0	...	294	0
White trap, involving coal	4	0	...	298	0
Blue-black shale, with coal-streaks and <i>Glossopteris</i>	5	0	...	303	0
Black shale, full of plant-remains	2	0	...	305	0
Dolerite, involving a little coal	1	6	...	306	6
Burnt coal (a)	0	6	...	307	0
White trap and burnt coal mixed	0	9	...	307	9
Calcite cavity, with pyrites crystals...	0	0½	...	307	9½
Burnt coal	0	0½	...	307	10
White trap	0	0½	...	307	10½
Burnt coal (a)	1	2	...	309	0½
Black shale, with <i>Glossopteris</i>	0	6	...	309	6½
Coal (good) (e)	5	5½	...	315	0
Coaly shale, with much carbonate of lime	0	4	...	315	4



SECTION OF NO. 1 BORE, PELICAN CREEK—*continued*.

	Thickness. Ft. in.		Depth. ft. in.	
Fine breccia of angular fragments of hard white clay and black shale, with coaly plant-streaks	1	3	316	7
Black shale, full of carbonised plant-remains, with coaly streaks	0	9	317	4
Fine breccia of angular fragments of hard white clay and black shale with coaly plant-streaks...	1	3	318	7
Black shales, with coaly streaks	3	0	321	7
Coal (good)	0	2	321	9
Black shale, with coaly streaks and occasional brecciated parts as above	3	3	325	0
Coal (only borings, drillings, and about $\frac{1}{2}$ -inch of core preserved). The drillings show coal of good quality mixed with shale; the $\frac{1}{2}$ -inch of core is good coal	0	6	325	6
Black shale, with coaly streaks and carbonised plants and occasional fragments of hardened clay	1	6	327	0
Black sandy shale, with carbonised plant-remains...	2	0	329	0
Coal (good), $\frac{1}{2}$ -inch of core	0	1	329	1
Black shale, with carbonised plant-remains	0	11	330	0
Coal (good), about 1 inch of core	0	6	330	6
Black shale, with carbonised plant-remains	2	0	332	6
Fine breccia of angular fragments of hard white clay and black shale, with coaly streaks	4	6	337	0
Dark-blue shale	0	6	337	6
Breccia, as above	0	6	338	0
Black shale	0	2	338	2
Dolerite, passing upwards and downwards into white trap	1	10	340	0
Black shale, with carbonised plant-remains	2	2	342	2
Breccia, as above, with coaly streaks	1	1	343	3
Coal layer	0	5	343	8
Black shale, with carbonised plant-remains	0	8	344	4
No record	6	8		
Black carbonaceous shale and fine-grained grey sandstone, at			351	0
Amygdaloidal porphyrite with steatite and calcspar	39	6	390	6

The burnt coals (*a*), at 72 feet 1 inch, 185 feet, 306 feet 6 inches, and 307 feet 10½ inches, were represented by a hard, heavy, earthy coke, full of pyrites and vertical veins of carbonate of lime. This coke decrepitates and flies off a charcoal fire. It leaves a dull-black stone after being heated to redness.

The burnt coal (*b*) at 188 feet 2 inches was represented only by drillings and small chips. From the drillings it appeared to be partly a slaty coal and partly a dark pyritous shale with coaly films. The bottom of the seam had an irregular and typically intrusive junction with the "white trap," as in Pl. 51, fig. 1.

The coal-seam (*c*) at 192 feet 9 inches was only represented by the drillings, and appeared from them to be a seam of alternate good coal and shale. The drillings burned fairly well in the forge.

The bottom of the coaly seam (*d*), struck at 286 feet 3 inches, was penetrated by intrusive "white trap."

The coal (e), at 309 feet 6½ inches, was the only seam of workable thickness and quality met with in the bore. The thickness of the seam, as reported by Mr. Hester, is 5 feet 5½ inches; but this was only represented by about 1 lb. of fragments, it having been found impossible to extract a core. The following is an analysis of this seam:—

	Per cent.
Moisture ... ..	1·15
Volatile hydrocarbons ... ..	20·25
Fixed carbon ... ..	61·87
Ash ... ..	17·03
	<hr/>
	100·00

Specific gravity, 1·56.

The coal swells a little on ignition, but falls away to a white ash without stirring. The powder is black. The coke swells a good deal, but is bright and firm. The seam would make a fair furnace coal, although the quantity of ash is certainly high.

In the bore, as in natural sections, the white trap graduates, as it recedes from the carbonaceous strata, into dolerite, although in natural sections it might be taken for a weathered acidic igneous rock. The junctions of the white trap and coal seen in the cores are most interesting and instructive. It would appear in some cases as if the coal had intruded into the white trap rather than the converse. The sample drawn in Pl. 51, fig. 1, shows this deceptive appearance very well. In Pl. 51, fig. 2, threads of coal penetrate the white trap like veins. In Pl. 51, fig. 3, the white trap occurs in irregular masses throughout the coal, these irregular masses being probably connected in the interior of the core, although they appear isolated in section. The molten rock appears to have, so to speak, eaten its way into the coal-seam and ultimately consolidated, while unconsumed fragments and films of the coal remained involved in its mass. The conversion of dolerite into white trap where it comes in contact with carbonaceous rocks has frequently been noted in the coalfields of Scotland and elsewhere.

J.

## CHAPTER XV.

### THE PERMO-CARBONIFEROUS SYSTEM—*continued.*

THE MIDDLE BOWEN FORMATION OUTSIDE OF THE TYPE DISTRICT,  
INCLUDING NEBO, MACKAY, BANANA CREEK, CRACOW CREEK, NOGOA RIVER, SPRINGSURE,  
LOGAN DOWNS, AND ROPER CREEK.

In the neighbourhood of Mackay generally the Permo-Carboniferous rocks are well represented. It will be convenient to give in this place a short account of the Middle or Marine Formation of the Bowen River as developed in the Nebo District.

Three miles south-west of Mount Britton Township, on a ridge near Mr. Richards' Selection, some beds of ferruginous, and in part calcareous, sandstones are seen dipping to the north-west. They are full of fossils of the type of the Middle or Marine Series. These are casts of numerous shells, &c., of which I made a large collection in 1887. The collection has been supplemented by Mr. A. L. Morisset, Mr. R. Hull, and others. Among the fossils identified by my Colleague are—

- Platycrinus? nux*, Eth. fil., Pl. 38, fig. 3.
- Spirifera*, *sp. ind.*, Pl. 38, figs. 4, 6.
- S. Strzeleckii*, De Kon., Pl. 10, fig. 37.
- Spiriferina duodecemcostata*, McCoy, Pl. 44, fig. 12.
- Martinia subradiata*, G. B. Sowerby, Pl. 11, fig. 14.
- Martiniopsis Darwinii*, Morris, Pl. 9, figs. 13, 14; Pl. 39, figs. 5, 7.
- Productus cora*, D'Orb., Pl. 12, fig. 14; Pl. 13, fig. 1; Pl. 38, fig. 11.
- P. brachythærus*, G. Sowerby, Pl. 12, figs. 10-13; Pl. 13, fig. 5; Pl. 44, fig. 14.
- P. subquadratus*, Morris, Pl. 38, figs. 7-10; Pl. 40, fig. 5.
- P.*, *sp. ind. (e)*, Pl. 37, fig. 18.
- Chonetes*, *sp. ind. (d)*, Pl. 37, fig. 19.
- Dellopecten illawarrensensis*, Morris, Pl. 41, fig. 3; Pl. 44, fig. 2.
- Modiomorpha mytiliformis*, Eth. fil., Pl. 14, fig. 5; Pl. 40, fig. 4.
- Orthoceras*, *sp.*, Pl. 15, fig. 1.

A species of *Fenestella* is also common.

The track from Mount Britton to Eungella passes by the Moonlight Diggings, east of Mount Robert and west of "The Stalk."\* Just beyond Mount Robert, fossils of the same species as those at Richards' were seen on the road.

The Middle Formation in the Mackay District is described by Mr. Maitland, in his Annual Report for 1889, as "made up mainly of sandstones and shales, and ferruginous sandstones, with occasional contemporaneous and intrusive sheets of dioritic rock." A few seams of coal occur among these beds.

On Banana Creek, a tributary of the Dawson (Lat. 24° 30', Long. 150°), a considerable addition has been made to the fauna of the Middle Formation by the labours of Mr. C. W. de Vis, Mr. H. Mackay, and the late Mr. James Smith. These are—

- Terebratula sacculus*, Martin.
- Spirifera lata*, McCoy.

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\* See Runs Map of Leichhardt District and Runs Map of North and South Kennedy, sheet 2.

*Martiniopsis ? subradiata*, G. B. Sby.

*Strophalosia Gerardi*, King.

" *Clarkei*, Eth.

*Modiomorpha mytiliformis*, Eth. fil.

*Chænomya Etheridgei*, De Koninck.

*C. carinata*, Eth. fil.

*Mourlonia ? coniformis*, Eth. fil.

*Bellerophon stanvelliensis*, Eth. fil.

*Porcellia Pearsi*, Eth. fil.

From Cracow Creek (south of Boolburra, Central Railway), on the Dawson River, Mr. R. Etheridge, F.R.S., described \* *Chonetes cracowensis*, Eth., and *Pleurotomaria (Platyschisma) rotunda*, Eth. The beds yielding these fossils may be presumed to belong to the Middle Formation.

From a locality described as "Weelwondongara Creek, Nogo River," which I am unable to identify, but which is probably on Wealwandangie squatting block, south of Springsure, the same Author described † *Productus* or *Strophalosia* (Pl. 18, figs. 4, 4a) (*Strophalosia Clarkei*, Eth.) This Brachiopod, as has already been seen, is very characteristic of the Middle or Marine Formation.

Mr. Smith, shortly before his death, forwarded, from the neighbourhood of Springsure, some Crinoid stems, and undoubted specimens of *Strophalosia Clarkei*, the latter, as has already been seen, being a characteristic fossil of the Middle Formation.

Mr. Rands records in his "Report on Clermont" that, on Logan Downs Run, forty miles north-north-east of Clermont, on the range west of Mount Rankin, Mr. Rogers-Harrison found "*Cyathophyllum* (two species), *Strophalosia Clarkei*, *Productus*, probably *P. brachythærus*, and *Arca*?" Probably these beds belong to the Middle Formation.

Daintree's Paper on the "Geology of Queensland" ‡ contains a list of fossils identified by Mr. R. Etheridge, F.R.S., "from the head of Roper Creek and the Bowen River," all characteristic of the Middle Bowen River Beds. It is strange that Daintree, of all men, should have mixed up fossils from different localities so that it is impossible to say which was which; but we may take it for granted that somewhere in the neighbourhood of Gordon Downs representatives of the Middle Bowen Series occur. The Roper Creek referred to is probably "Little Roper's Creek," a tributary of Sandy or Campbell's Creek, which will be found on the map between the 22nd and 23rd Parallels of Latitude and the Meridians of 148 and 149. Daintree's Paper also contains (p. 283) a list of apparently Cretaceous fossils from "Gordon Downs, at the head of Roper Creek," sent by the Revd. W. B. Clarke to Mr. R. Etheridge, F.R.S. The words "at the head of Roper Creek" are here probably inserted by mistake. There is a station named Gordon Downs near Roma, which is a Cretaceous locality.

J.

\* Quart. Journ. Geol. Soc. Lond., xxviii., pp. 336, 337.

† Loc. cit., p. 334.

‡ Quart. Journ. Geol. Soc., xxviii., p. 286.

## CHAPTER XVI.

### THE PERMO-CARBONIFEROUS SYSTEM—continued.

#### LIFE OF THE MIDDLE BOWEN FORMATION.

THE following is a complete List of the Fossils identified or admitted by my Colleague from this formation in all the localities where it occurs:—

<i>Sphenopteris lobifolia</i> , Morris.	<i>Derbyia senilis</i> , Phill.
<i>Glossopteris Browniana</i> , Brong.	<i>Productus cora</i> , D'Orb.
„ <i>linearis</i> , McCoy.	„ <i>brachythærus</i> , G. Sow.
„ <i>ampla</i> , Dana?	„ <i>subquadratus</i> , Morris.
Coniferous wood.	„ <i>sp. ind. (e)</i> , Pl. 37, fig. 18.
<i>Stenopora australis</i> , Nich. and Eth. fil.	<i>Strophalosia Clarkei</i> , Eth.
„ <i>Leichhardtii</i> , N. and E. fil.	„ <i>Gerardi</i> , King.
„ <i>Jackii</i> , N. and E. fil.	<i>Chonetes cracowensis</i> , Eth.
<i>Platycrinus? nux</i> , Eth. fil.	„ <i>sp. ind. (d)</i> , Pl. 37, fig. 19.
Crinoid stems.	<i>Aviculopecten subquinguelineatus</i> , McCoy.
<i>Mesoblastus? australis</i> , Eth. fil.	„ <i>limæformis</i> , Morris.
<i>Fenestella fossula</i> , Lonsd.	<i>Deltopecten illawarrensis</i> , Morris.
<i>Protoretepora ampla</i> , var. <i>Woodsii</i> , Eth. fil.	<i>Merismopteria macroptera</i> , Morris.
<i>Protoretepora ampla</i> , var. <i>Koninckii</i> , Eth. fil.	<i>Modiomorpha mytiliformis</i> , Eth. fil.
<i>Terebratula cymbæformis</i> , Morris.	<i>Solemya Edelfelti</i> , Eth. fil.
<i>Dielasma sacculus</i> , Martin, var.	<i>Astartila cytherea</i> , Dana.
<i>Spirifera striata</i> , Martin?	<i>Chænomya? Etheridgei</i> , De Kon.
„ <i>convoluta</i> , Phill.	„ <i>carinata</i> , Eth. fil.
„ <i>lata</i> , McCoy.	„ <i>acuta</i> , Eth.
„ <i>Clarkei</i> , De Kon.	„ <i>bowenensis</i> , Eth. fil.
„ <i>trigonalis</i> , Martin.	<i>Pachydomus globosus</i> .
„ <i>sp. ind. (b)</i> , Pl. 38, figs. 4-6.	<i>Mæonia carinata</i> , Mor.
„ <i>tasmaniensis</i> , Morris.	„ <i>recta</i> , Dana.
„ <i>Stokesii</i> , König.	<i>Platyschisma rotunda</i> , Eth.
„ <i>Strzleckii</i> , de Kon.?	<i>Mourlonia? coniformis</i> , Eth. fil.
<i>Spiriferina duodecemcostata</i> , McCoy.	<i>Bellerophon stanvillensis</i> , Eth. fil.
<i>Martiniopsis? subradiata</i> , G. B. Sby.	<i>Porcellia Pearsi</i> , Eth. fil.
„ <i>Darwinii</i> , Morris.	<i>Orthoceras</i> , sp.
	<i>Goniatites micromphalus</i> , Morris.

Of the above, *Glossopteris ampla?*, *Stenopora australis*, *S. Leichhardtii*, *S. Jackii*, *Platycrinus? nux*, *Protoretepora ampla*, var. *Woodsii*, *P. ampla*, var. *Koninckii*, *Terebratula cymbæformis*, *Dielasma sacculus*, *Spirifera striata*, *S. convoluta*, *S. Clarkei*, *S. sp. ind. (b)*, *Spiriferina duodecemcostata*, *Productus*, *sp. ind. (e)*, *Strophalosia Clarkei*, *S. Gerardi*, *Chonetes*, *sp. ind. (d)*, *Aviculopecten subquinguelineatus*, *Deltopecten illawarrensis*, *Merismopteria macroptera*, *Modiomorpha mytiliformis*, *Solemya Edelfelti*, *Astartila cytherea*, *Chænomya? carinata*, *C.? acuta*, *C.? bowenensis*, *Pachydomus globosus*, *Mæonia carinata*,

*M. recta*, *Mourlonia*? *coniformis*, and *Goniatites micromphalus* occur only in the Middle Bowen Formation and are not known from any of the other subdivisions of the Permo-Carboniferous.

*Chonetes cracowensis*, *Porcellia Pearsi*, and *Orthoceras*, *sp.*, are common to the Gympie, Star, and Middle Bowen Formations.

*Fenestella fossula*, *Spirifera lata*, *S. trigonalis*, *S. Stokesii*, *S. Strzleckii*?, *Martinia subradiata*, *M. Darwinii*, *Productus cora*, *P. brachythærus*, *P. subquadratus*, *Aviculopecten limæformis*?, *Chænomya*? *Etheridgei*?, *Platyschisma rotunda*, and *Bellerophon stanvelliensis* occur in the Middle Bowen and Gympie Formations, but not in any of the other subdivisions of the Permo-Carboniferous.

*Sphenopteris lobifolia*, *Glossopteris Browniana*, *G. linearis*, and *Derbyia senilis* occur both in the Middle and Upper Bowen Formations, but not in any of the other subdivisions of the Permo-Carboniferous.

*Productus brachythærus* is common to the Gympie as well as to the Middle and Upper Bowen Formations.

The following Genera are common to the Middle Bowen and Gympie Formations:—

ACTINOZOA: *Stenopora*.

POLYZOA: *Fenestella* and *Protoretetepora*.

MOLLUSCA: *Dielasma*, *Spirifera*, *Martiniopsis*, *Productus*, *Chonetes*, *Aviculopecten*, *Modiomorpha*, *Astartella*, *Chænomya*, *Mourlonia*, *Bellerophon*, *Porcellia*, *Orthoceras*, and *Goniatites*.

The following Genera are common to the Middle Bowen and Star Formations:—

POLYZOA: *Fenestella*.

MOLLUSCA: *Spirifera*, *Spiriferina*, *Chonetes*, *Porcellia*, and *Orthoceras*.

The following Genera are common to the Middle and Upper Bowen Formations:—

PLANTÆ: *Sphenopteris* and *Glossopteris*.

MOLLUSCA: *Derbyia*, *Productus*, and *Goniatites*.

J.

## CHAPTER XVII.

### THE PERMO-CARBONIFEROUS SYSTEM—*continued*.

#### THE UPPER BOWEN FORMATION IN THE TYPE DISTRICT.

THE uppermost beds of the Middle Formation dip at a comparatively low angle, and conformably, to the east, beneath the lowest beds of the Upper Formation in the Bowen River, near the mouth of Cockatoo Creek. The dip gradually becomes flatter for about eight miles up the river, till, at the mouth of Jack's Creek, the strata are horizontal. Thence they gradually rise for about five miles further up the river, when a bed of grey sandstone, dipping at 50° to S.W., and full of *Strophalosia Clarkei*, Eth., is seen crossing the river. This sandstone, and the strata which succeed it for the next mile up the river, all belong to the Middle Series.

To the north of the Bowen River, the Upper Formation comes directly in contact, through the agency of a fault, with the older metamorphic rocks of the Clarke Range, consisting here of quartzites, shales, greywackes, &c.

With the exception of the coal-seams the strata of the Upper Formation consist almost entirely of grey shales and greenish-grey sandstones, which are occasionally pebbly. The total thickness of the Upper Formation cannot be estimated, as its upper beds are not seen; but from the lowest bed to the axis of a synclinal trough in Rosella Creek there must be at least 1,000 feet of strata.

The Daintree Coal-Seam crops out in the bed of the Bowen River, about a quarter of a mile below the mouth of Rosella Creek. Its position is evidently very near the base of the Upper Series. Above the coal, a sheet of dolerite, about twenty-five feet in thickness, occupies the bed of the river for one hundred yards. The lower portion of the dolerite has been converted into white trap. Its actual base is concealed by a talus, a gap of perhaps ten feet intervening between the dolerite and the underlying strata. The following is the section, which dips to E.S.E. at 7°:—

		Ft.	In.
Dolerite, the lower part white trap		25	0
Gap—room for		10	0
Daintree Seam.	Burnt coal, partly columnar; somewhat coked in part; veins and pockets of white trap in upper part; concretions of ironstone in vertical and horizontal joints; nodules of decomposed pyrites; <i>Glossopteris</i> recognisable in parts	3	7
	Black shale	0	1
	Burnt coal	0	3
	Black shale	0	1
	Burnt coal	0	6
	Black shale	0	1
	Burnt coal	0	10
	Bluish-grey shales	1	2
	Stony burnt coal with silky plant-débris (a)	0	6
	Light porous crumbling coal, with concretionary nodules of better coal (c)	0	8
	Coaly shale	0	2
	Light brownish-black laminated coal (some of the laminæ rather oil-shale than coal), fair quality (b)	7	0
	Bluish-black shales	2	3
	Good coal (a)	0	3

	ft.	in.
Dark-blue shales, with <i>Phyllothea</i> , &c. (some laminae coaly), say	10	0
Flaggy brown sandstone with plant-remains	0	10
Ironstone	0	1
Bluish-grey shales	1	6
Brown sandstone with ferruginous concretions	0	3
Brown flaggy sandstone, with plant-remains	1	6
Grey shales, with 1½-inch band of good clayband ironstone	4	0

The coal from the seam marked (*d*) upwards has been destroyed by the igneous rock, which wanders through it in the form of veins and "pockets," renders it columnar, and converts it partly into a kind of stony coke and partly into an earthy graphite. The coal beneath is less injured, and the three-inch band marked (*a*) presents no visible sign of having suffered from the heat radiated from the intrusive dolerite.

The band marked (*a*) is jet black and lustrous, with, however, some dull laminae. It took fire easily and burned with a fierce heat, caking, giving out much gas, and leaving but little ash. The coal takes a polish under the knife. The powder has a lead-black hue. The coal (at least at its weathered outcrop) has a tendency to break up in right rhombic prisms. It has reticulating films of calcite in the joints. Its specific gravity is 1.453.

## ANALYSIS.

Water	...	...	...	...	1.91
Volatile hydrocarbons	...	...	...	...	20.02
Fixed carbon	}	Coke, 78.07 per cent.	{	...	63.60
Ash (white)				...	14.47

100.00

The coke is tender, and swells unequally along the laminae.

The seam marked (*b*) is rather slaty at the bottom, with alternate dull and shining laminae. This portion burned with difficulty and left a good deal of ash. The upper portion of the seam took fire easily, crepitated loudly at first (probably from moisture), emitted a good deal of gas, and then fell away leaving little ash except from some shaly laminae. The purer layers of coal tend to split up in rectangular prisms, but are otherwise very firm. The coal takes a fine brownish-black polish. Its powder is lamp-black.

The upper part of the seam appears to be more homogeneous than the lower. The laminated structure is equally distinct in both, but the lower appears to be more broken up by shaly partings.

## ANALYSIS OF TOP OF SEAM.

Water	...	...	...	...	2.44
Volatile hydrocarbons	...	...	...	...	15.72
Fixed carbon	...	...	...	...	57.40
Ash	...	...	...	...	24.44

100.00

Specific gravity, 1.42.

## ANALYSIS OF BOTTOM OF SEAM.

Water	...	...	...	...	2.50
Volatile hydrocarbons	...	...	...	...	13.09
Fixed carbon	...	...	...	...	57.14
Ash	...	...	...	...	27.27

100.00

Specific gravity, 1.513.

The bed marked (*c*) will hardly burn at all, and is in fact mere stone.





involved in the dolerite, while at the east side the section in Plate 51, fig. 4, remains to attest the presence of a good coal-seam before the destroying mass of molten dolerite forced its way among the beds.

In a little gully entering the right bank of Rosella Creek about half-a-mile from its mouth, the following are seen lying horizontally. Their horizon cannot be very far above the Daintree Seam.

								Pt.	in.
Dolerite (intrusive sheet), weathering spheroidally	...	...	...	...	...	...	...	15	0
Hardened blue shales (a)	...	...	...	...	...	...	...	0	6
Blue shales, with plants	...	...	...	...	...	...	...	1	3
Lenticular ironstone band	...	...	...	...	...	...	...	0	4
Blue shales	...	...	...	...	...	...	...	0	4
Soft lenticular coal-seam	...	...	...	...	...	...	...	0	1
Ferruginous shales	...	...	...	...	...	...	...	0	6
Blue shales, with plants	...	...	...	...	...	...	...	0	9
Lenticular coal-seam	...	...	...	...	...	...	...	0	0½
Lenticular ironstone seam	...	...	...	...	...	...	...	0	0½
Blue shales	...	...	...	...	...	...	...	1	6
Lenticular mass of mineral pitch (b)	...	...	...	...	...	...	...	0 to 0	4
Blue shale, with plants, and very thin lenticular coal and ironstone seams	...	...	...	...	...	...	...	3	0

The juncture of the dolerite with the underlying blue shales, marked (a) in the above section, is very remarkable, and shows that the shales were broken and torn by the intrusion of the dolerite, as in Plate 51, fig. 5.

The mass of mineral pitch, (b) in the above section, appears to occupy an irregular pocket in the shales, as shown in Plate 52, fig. 1. The origin of a cavity of such a form is difficult to explain.

The next important coal-seam is named the MacArthur. It is seen in Jack's and MacArthur Creeks, on the right and left banks of the Bowen River respectively, about eight miles above the mouth of Rosella Creek. Its position must be some distance above that of the seam met with at No. 19 Traverse Station.

The MacArthur Seam on Jack's Creek was prospected in 1875 in a "drive" by the Bowen River Coal Association. The drive is said to have exposed a seam of coal five feet in thickness, but worthless owing to the intrusion of a sheet of dolerite.

Near the mouth of the creek, about twenty feet of fine-grained grey argillaceous sandstone bands, with plant-remains and grey shales, are cut out and overlaid by an almost horizontal sheet of dolerite, which forms the upper half of the low hill in the angle between the creek and the river. The dolerite weathers spheroidally. The nature of the junction of the igneous and stratified rocks is sketched in Plate 52, fig. 2.

In MacArthur Creek, the MacArthur Seam and other strata are seen associated with an intrusive dolerite as in the following section. The strata are horizontal:—

								Pt.	in.
MacArthur Seam.	Dolerite (on top of bank)	...	...	...	...	...	...	12	0
	Burnt coal	...	...	...	...	...	...	0	2
	Grey shale	...	...	...	...	...	...	5	0
	Burnt coal, with shaly layers	...	...	...	...	...	...	1	7
	Hard grey ferruginous sandstone	...	...	...	...	...	...	0	4
	Burnt shaly coal	...	...	...	...	...	...	1	7
	Grey-brown sandstone, with plant-impressions	...	...	...	...	...	3 in. to	0	7
	Grey shales	...	...	...	...	...	...	0	3
	Darker shales, with coaly laminæ	...	...	...	...	...	...	0	9
	Bituminous coal (tolerable)	...	...	...	...	...	...	0	1
	Grey sandstone	...	...	...	...	...	...	0	1
	Crumbling coal, with shaly laminæ, the coal laminæ of fair quality,	1 ft. to	1	9					

	Ft.	in.
Grey shaly fireclay, with rootlets ... ..	0	4
Darker shale ... ..	0	8
Grey-brown ferruginous shale—a mass of <i>Glossopteris</i> ... ..	0	4
Crumbling brown shale ... ..	0	5
Grey-brown ferruginous shale—a mass of <i>Glossopteris</i> ... ..	0	3
Grey shale, with <i>Glossopteris</i> , &c. ... ..	...	...
Grey sandstone, thin-bedded, with occasional plant-remains ... ..	30	0

Mr. A. C. Gregory reported as follows on a sample of the MacArthur Seam:—

Volatile in coking ... ..	28.8
Fixed carbon ... ..	38.6
Ash ... ..	32.6
	<hr/> 100.0

Specific gravity, 1.67.

"The specimen appears to be injured by weather, and the coal will probably improve at a greater depth. The percentage of ash is so high that the coal would be of little value unless, by a careful selection from the best parts of the seam, the proportion of ash should be lessened." Mr. Gregory had no opportunity of seeing the true cause of the deterioration of the coal.

Near the head of Jack's Creek the strata of the Upper Series are thrown down by a fault against the older quartzites, greywackes, &c., of the Clarke Range, and on approaching the fault become nearly vertical. The strata consist mainly of dark shales, with thin beds of hardened sandstone, and there are also a few beds of dark-blue crystalline limestone, apparently unfossiliferous. These are the only limestones which I observed in the Upper Series—at least in the type district. A dolerite dyke which has come up along the bedding-planes of the shales and sandstones throws off a branch at an angle of 45°, which "jumps" without being shifted by any fault, as sketched in Pl. 52, fig. 4.

For three miles up Jack's Creek, above the level of the MacArthur Coal-Seam, the strata are horizontal, so that their thickness is equal to the fall of the creek—probably less than two hundred feet. The section is, however, very imperfect, the rocks being only exposed at long intervals, except in the lower reaches of the creek. These are invariably either grey shales or greenish-grey sandstone, which is sometimes pebbly. About a mile north of the river a thickness of about fifty feet of greenish-grey sandstone is seen, containing numerous large drifted coniferous trees. The trees, which are silicified to a black flint, and sometimes opalised, occasionally retain some of the branching roots. Fragmentary plant-remains, in a carbonised condition, are also common. About half a-mile from the river the creek divides into two branches, both of which show, for some distance up, section of the greenish-grey pebbly sandstone, with silicified drifted trees. One tree measured thirty-one feet in length, and tapered from twelve inches to three inches in diameter.

On the road from Havilah to Biralee, about a quarter of a mile west of Rosella Creek, large silicified trees lie on the surface, in one of which I counted about thirty rings of growth. Between the second and third Traverse Stations on Rosella Creek, the following strata, which dip to S. at 15°, are seen on the right bank:—

	Feet.
Bluish cross-bedded sandstone, weathering spheroidally, full of carbonised and silicified plants, including coniferous trees. Large unrounded boulders of metamorphic rock occur sporadically throughout—about ... ..	150
Dolerite sheet ... ..	10
Grey shales and finely laminated sandstone, with thin bands of sandy ironstone ... ..	50

The strata in the above section are believed to be identical with those which are seen up Jack's Creek.

About a hundred yards above No. 2 Traverse Station, on Rosella Creek, a dolerite sheet is seen, involving lumps of coal, and probably occupying the position of a coal-seam. It dips to S. at 15°.

Occupying apparently a position above the thick beds of sandstone above referred to is the Havilah Coal-Seam, seen on the left bank of Rosella Creek, where the paddock fence crosses. The following is the section, which has a slight dip to the north-east:—

	Pt.	in.
Dolerite sheet on top of left bank.		
Havilah Coal-Seam, burnt by "white trap" intruded along bedding, and rendered columnar, especially in upper part ... ..	10	6
(About 200 yards up the creek, the place of the coal is taken up by the sheet of dolerite, which steals down into it.)		
Dark and grey shales, with a two-feet bed of soft worthless coal in the middle ... ..	30	0
Greenish-grey sandstone, with trees.		
Blue-grey shales, with plants, and lenticular seams of coal, and calcareous bands, and bands of ironstone nodules (slight dip to north-east).		

The shales seen in the above section appear to die out up-stream, and a considerable thickness of greenish-grey sandstone takes their place. A quarter of a mile higher the sandstone is pierced by a 3½-feet dyke of dolerite, running E. 10° N., and the lower coal-seam is again seen on the left bank. The Havilah Seam is burnt by "white traps" intruded along the bedding, and is rendered columnar, especially in the upper part. (*See* Sketch, Pl. 52, fig. 3.)

The Havilah Coal-Seam is not very far from the uppermost beds of the Upper or Freshwater Series, as, after dipping to the south-east, the strata in a mile or two begin to rise again in that direction. About a mile above the road from Havilah to Byerwin, where it crosses Rosella Creek, there occur some beds of grey and reddish ferruginous sandstones. In these beds marine fossils are numerous and well preserved. *Derbyia senilis*, Phillips, is specially abundant. Loose blocks of silicified wood, apparently from a higher bed which has been denuded, cover the shell beds. The reappearance, high up in the Upper Series, which from its base upward has so far yielded nothing but plant-remains, of strata charged with marine fossils, and these of species which also occur in the Middle Series, is of the highest importance with reference to the continuity of the two series. An analogous fact is the appearance of *Glossopteris* in the Middle Series (even down to near the base, as evidenced by the Pelican Creek Bore), associated with its characteristic marine fossils.

## CHAPTER XVIII.

### THE PERMO-CARBONIFEROUS SYSTEM—*continued*.

#### THE UPPER BOWEN FORMATION OUTSIDE OF THE TYPE DISTRICT,

INCLUDING NEBO, MACKAY, LENTEN DOWNS, ISAACS AND DAWSON RIVERS, CEMENT HILL, CLEDMONT,  
BLAIE ATHOLE, AND DINNER CREEK, STANWELL.

On the right bank of Bee Creek, above its junction with Hail Creek, two shafts known as "Walker's" were sunk about ten years ago. The shafts have tumbled in, and there is no evidence to show whether they reached or cut through the strata exposed in the bank of the creek, which are as follow:—

	Ft.	in.
Dark shale with coaly streaks	5	0
Fireclay	0	5
Shale	0	8
Sandy fireclay	4	2
Coaly seam	0	4
Sandstone	0	5
Laminated fireclay	0	3
Coaly shale	0	7
Fireclay	0	9
Coaly seam	0	3
Fireclay	0	3
Coaly seam	0	11
Fireclay	0	6
Coaly seam	0	2
Fireclay	0	2
Coaly seam	0	4
Fine sandstone	0	5
Coaly seam	0	6

The coaly seams of the above section are composed of black carbonaceous mud, with streaks and films of coal. A waterworn sample of coal from the bed of the creek had a specific gravity of 1·57, and contained—

Water	2·87
Volatile hydrocarbons	12·61
Fixed carbon (hard stony coke)	60·91
Ash (white)	23·61

100·00

The strata are horizontal, but about a quarter of a mile down the creek some beds of greenish-grey sandstone, containing silicified wood, and bearing a strong resemblance to the strata of the Upper Series on the Bowen River Coal Field, as exposed in Jack's Creek, dip slightly to the west.

In the bed of Walker's Creek, about two miles above its junction with Reedy or Carborough Creek, three small shafts have been sunk on a coal-seam, but in no case has the bottom of the seam been reached. The following section is seen on the bank and in the shafts. The strata dip at 5° to E.S.E.

										Ft. in.
Sandy shale with lines of very large ferrugino-calcareous nodules in upper part and lines of ironstone nodules in lower part. ( <i>Glossopteris</i> abundant; also a specimen of <i>Pecopteris</i> !)*										13 2
Laminated fireclay (sometimes sandy)										2 0
Compact fireclay ( <i>Phyllothea</i> abundant)										0 8
Dark shale										0 2
McFadzean's Seam.	Coal	...	...	...	...	...	...	...	...	3 5
	Grey shale	...	...	...	...	...	...	...	...	0 to 0 1½
	Coal	...	...	...	...	...	...	...	...	0 2
	Hard red ironstone	...	...	...	...	...	...	...	...	0 to 0 3
	Coal (bottom not seen)	...	...	...	...	...	...	...	...	0 9

Some sandstone beds in the neighbourhood contain silicified logs, and similar logs, evidently weathered out of the sandstone, bestrew the surface in the neighbourhood so thickly that one might imagine a forest to have been felled on the spot and subsequently petrified. In travelling from the mine to South Fort Cooper I found the country similarly strewn with silicified wood as far as Bee Creek. There can be no doubt that the coal-measures of this district are on the horizon of the Upper Bowen River Formation. A gratifying and promising circumstance is the absence of intrusive igneous rocks from this district. A specimen analysed had a specific gravity of 1.38, and contained—

Water	...	...	...	...	...	...	...	2.99
Volatile hydrocarbons	...	...	...	...	...	...	...	8.71
Fixed carbon (firm hard coke)	...	...	...	...	...	...	...	84.74
Ash (pale brown)	..	...	...	...	...	...	...	3.56

---

100.00

The coal of Walker's Creek is an anthracite containing a higher percentage of fixed carbon and a lower percentage of earthy impurities than any coal of its class known in Queensland or New South Wales. It approaches in composition some of the best anthracites of Wales and Pennsylvania. The Bee Creek coal visibly contains a large proportion of argillaceous impurity, resulting in 23.61 per cent. of ash.

In 1889, Mr. A. Gibb Maitland mapped † the Coal-Measures in the neighbourhood of Mackay, and connected his lines with those on the Bowen River, mapped by me in 1878. With the Annual Report of the Geological Survey for 1889 a Geological Map is given, showing the connection of the Bowen River Coal Field with that on the head of the Isaacs.

It appears that the Upper Formation extends south-eastward from the Bowen River up Rosella Creek and the heads of the Bowen, where it is capped by the Desert Sandstone Tablelands known as Mount Leslie and the Redcliffe Range, across the high land dividing the heads of the Bowen, the Sutor, and the Isaacs Rivers and Walker's Creek, gradually widening from north-west to south-east, and capped at the heads of the Isaacs by the Desert Sandstone Tablelands known as the Carborough Ranges. The Middle Formation has been traced on the north-eastern side of the Upper Formation, beneath which it emerges, from the head of the Bowen River south-eastward to Nebo. The bedded porphyrites emerge from beneath the Middle Formation from the Bowen River to Exmoor Station. The fault already mentioned divides the bedded porphyrites from the metamorphic rocks of the Clarke Range along a line extending from the head

\* Probably two species of *Glossopteris* occur here, one possessing a broad thick midrib. The specimen named *Pecopteris*! is certainly this genus or a very closely allied one. These plants still remain to be worked out. (*R.E. Junr.*)

† On the Geological Features and Mineral Resources of the Mackay District. Brisbane: by Authority: 1889.

of Pelican Creek to the Bowen River, near Exmoor. From Exmoor south-eastward to a point between Mount Illalong and Eungella Station, the fault divides the Middle Formation from the metamorphic rocks. Thence south-eastward to the granite range of Mount Dalrymple the Lower Formation comes in immediate contact with the metamorphic rocks, sweeps round the granite range, on the coastward side, by Mackay and Bloomsbury Station, and, on the south, surrounds the granite mass of Mount Bridgman and Mount Spencer, reaching the sea near Cape Palmerston.

Beneath the Desert Sandstone of the Carborough Range the Upper Formation of the Bowen River Coal Field is seen. Plant-remains, including *Glossopteris* and (?) *Sphenopteris*, were observed by Mr. Maitland in some sandy micaceous shales at a waterfall in Bee Creek. A few yards up the creek a seam of impure coal, one foot in thickness, dips to N. at 10°. A tributary of the same creek exposes a seam of coal at least six feet in thickness, but interrupted by bands of carbonaceous shale.

About three miles west of Lenton Downs Station a bed of coal, two feet in thickness and of fair quality, was met with in a well at a depth of about fifty feet. A similar seam was met with in a well between Lenton Downs and Greendale.\*

From the heads of the Isaacs to the heads of the Dawson the whole country appears to be made up of strata belonging to the Bowen River Formation, but our knowledge of this district is very limited. Mr. Daintree, in 1872,† besides the Bowen River, mentioned the occurrence of Palæozoic Coal-Measures on the Dawson, Comet, Mackenzie, and Isaacs, remarking that "numerous outcrops of coal have been observed on these streams. No commercial use, however, has yet been made of any of them, as the measures generally are too far inland to be made available until the railway system of the country is extended in that direction." From considerations already given I have divided this area between the Middle and Upper Formations of the Bowen Coal Field.

Mr. Daintree described, in 1870,‡ certain auriferous drifts at Cement Hill, about sixteen miles from Clermont. Mr. Rands gave a fuller account of the same deposit in his "Report on the Clermont District."§ The hill consists of (1st) fifteen to thirty feet of conglomerate, composed of boulders and pebbles of schist and also small quartz pebbles, the whole cemented together by clayey cement formed from the degradation of the schist. The lower four or five feet of the conglomerate form the washdirt in which the gold is found. (2nd) Beneath the conglomerate is a fine-grained silt or shale, from one to four feet in thickness, dipping W.S.W. at from 5 to 25°. Numerous well-preserved impressions of *Glossopteris* occur in this silt. (3rd) Beneath the silt or shale is another drift, much finer than the upper one, consisting of small schistose pebbles, but containing much more quartz, the quartz pebbles often predominating. This drift, which is locally known as "tish," is in places forty feet in thickness. In some parts of the hill the *Glossopteris* shale rests immediately on the schists, but oftener on the "tish." It is in some places over forty feet in thickness. No gold has been found in the lower drift.

At Hurley's, and at the Four-mile near Clermont, the drift is of the same character as that at Cement Hill, and *Glossopteris* is also found at Hurley's.

The Victoria Lead, east of Cement Hill, shows the following section:—

	Feet.
Basalt ... ..	40
Gravelly quartz drift (lower 3 or 4 feet containing gold) ... ..	60
"Tish" as above described ... ..	79

\* Geol. Obs. at the Heads of the Isaacs, the Suttor, and the Bowen Rivers. By A. Gibb Maitland. Brisbane: by Authority: 1889.

† Quart. Journ. Geol. Soc. Lond., xxviii., p. 285.

‡ General Report upon the Northern District. Brisbane: by Authority: 1870, p. 3.

§ Brisbane: by Authority: 1886.

While the presence of *Glossopteris* was relied upon as an infallible indication that the beds in which it occurred were of Palæozoic age, the above, of course, were ranked as the oldest known auriferous drifts in Queensland, and were supposed to have derived their gold from the denudation of a land surface which existed in Permo-Carboniferous times. Mr. Rands' recent discovery of *Glossopteris* in the Upper Cretaceous Desert Sandstone gives, however, a new signification to the argument derived from the presence of that plant. The beds in which it occurs—at least when it is unaccompanied by other fossils—may be of any age from the Lower Bowen to the Desert Sandstone.

The same remarks apply to certain deposits in New South Wales, described as quoted below by the late Mr. C. S. Wilkinson, Government Geologist,\* as their supposed Carboniferous age depends solely on the presence of *Glossopteris*.

"North of Gulgong, at Tallawang, the coal measures cover a large extent of country, their lowest beds having been found to be payably auriferous. I reported this interesting discovery to you in November last, stating that during my examination of the Tallawang Gold Field Reserve I observed the important fact that the gold found in the Tertiary alluvial deposits at the old Tallawang and Clough's Gully Diggings has been chiefly derived from conglomerates in the coal measures. These conglomerates are associated with beds of sandstone and shale, containing *Glossopteris*, the fossil-plant characteristic of our coal measures. At Clough's Gully the conglomerate is being worked *in situ*, and yields from 1 to 15 dwt. of gold per ton, while nuggets weighing 5 oz. have been obtained from it. Several hundreds of tons of the conglomerate (locally termed cement) have been crushed, but as the yield is said to have been patchy or variable, work has been stopped, and the ground is now held under lease. There are, however, a few miners still at work in the adjacent claims, and I took the opportunity of purchasing from one of them a sample weighing 1 oz., of the gold which he was crushing by hand out of hard cement. The gold is coarse in size, remarkably scaly, and waterworn. I hope to secure for the Museum of Mines some samples of the conglomerate containing gold. Mr. R. McKay, of Clough's Gully, gave me one small piece showing coarse gold.

"This is the first time that gold has been noticed as occurring in payable quantity in the coal measures of this colony, and it is not unworthy of remark that we here possess one of the most ancient auriferous alluvial deposits in the world!"

At Blair Athole Station, ten miles north-west of Clermont, in a well sixty feet deep, a seam of coal, together with yellow and grey sandstones, with bands of fine-grained fissile sandstone and shale, were met with, dipping at 10° to S.E. From the *Peak Downs Telegram* of 1st March, 1873, we learn that the seam was about six feet thick, and at a depth of about seventy feet from the surface, and that another seam, two feet thick, lay about three feet below it. In a bore sunk by the Peak Downs Copper Company, a hundred yards from the Blair Athole well, a four-feet seam of coal was met with at one hundred feet.

From the *Peak Downs Telegram* of 30th November, 1889, we learn that in 1889 another shaft was sunk seven hundred yards distant from the well, in which was the following section:—

											Feet.
Surface	...	...	...	...	...	...	...	...	...	...	5
Sandstone	...	...	...	...	...	...	...	...	...	...	80
Shale	...	...	...	...	...	...	...	...	...	...	7
Sandstone	...	...	...	...	...	...	...	...	...	...	3
Coal	...	...	...	...	...	...	...	...	...	...	5

\* Ann. Report Dep. Mines, N. S. Wales, for 1876 (1877), pp. 173, 174.



The coal was tested by the Locomotive Foreman on the Central Railway. With a consumption of 3 tons 16 cwt., or about 29 lb. per mile, the engine ran 286 miles, with an average load behind the tender of 108 tons. The coal is described as "light," and its steaming qualities as "good."

From Dinner Creek, near Stanwell, Mr. James Smith has forwarded to me numerous specimens of *Glossopteris*, &c.,\* which appear to indicate that in this locality strata equivalent to the Upper Series occur. Seams of coal have been met with in this neighbourhood. The unaltered, and not much disturbed sandstones and shales of this formation are clearly distinct from the highly inclined, and considerably altered, fossiliferous rocks (Gympie Beds) of Stony Creek, Stanwell, and also from the Mesozoic Beds of Stewart's Creek, Stanwell.

From its organic remains, lithological character, and position, I have no hesitation in regarding the Upper Bowen Formation as the equivalent of the "Tomago, East Maitland, Series (productive coal measures), 5,700 feet thick; Dempsey Series (barren freshwater beds), 2,000 feet thick; and Newcastle Series (productive coal measures), about 1,150 feet thick," of New South Wales.†

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\* There are apparently three distinct species of *Glossopteris* and a *Pecopteris*. This material has still to be worked out. (*R.E. Junr.*)

† A Correlation of the Coal Fields of New South Wales, by T. W. Edgeworth David, B.A., F.G.S. *Proc. Austr. Assoc. Adv. Science*, 1890, ii., p. 464.

## CHAPTER XIX.

### THE PERMO-CARBONIFEROUS SYSTEM—*continued.*

#### THE UPPER BOWEN FORMATION OUTSIDE OF THE TYPE DISTRICT—*continued.*

##### INCLUDING TOWNSVILLE, OAKY CREEK, AND LITTLE RIVER, COOKTOWN.

NORTH of the Bowen River, strata of the age of the Upper Formation of the Bowen River Coal Field are met with in the neighbourhood of Townsville and Cooktown.

A cutting on the Northern Railway, near Stewart's Creek Station, exposes some thin beds of conglomerates, sandstones, shales, and fireclays, which have yielded *Glossopteris*. A sheet of porphyry is intruded among the strata. During the progress of some excavations for the purpose of straightening a curve, some thin lenticular seams of coal were exposed. Of one of these I made the following analysis in 1887:—

Water	...	...	...	...	...	...	...	...	7.18
Volatile hydrocarbons	...	...	...	...	...	...	...	...	46.66
Fixed carbon	...	...	...	...	...	...	...	...	37.89
Ash	...	...	...	...	...	...	...	...	8.29
									100.00

Similar beds are seen on the adjacent Aboriginal Reserve, where an adit driven horizontally into a hillside exposed beds containing *Glossopteris* and other undetermined plants in large numbers. Here the shales and sandstones are interstratified with beds of volcanic origin.

At a point on the hillside nearly due south of an old bore sunk by the Townley Coal Company, a sandstone bed, seven inches thick, rests upon shales and is covered by a sheet of lava. Near the south-eastern extremity of the hills, about 180 feet above the sea-level, blue-black shales and six inches of impure coal lie horizontally beneath volcanic ash.

At one spot the shales are "porcellanised," but the induration does not appear to extend for any great distance. These baked shales dip at 23° to S.S.E., and rest upon and are covered by volcanic rocks.

"The age of these volcanic rocks appears to be contemporaneous with the beds at Stewart's Creek." \*

At Stewart's Creek Railway Station the rocks already described are faulted against volcanic ashes. These, at a height of 120 feet above the station, on the western bank of one of the heads of Stewart's Creek, show what appear to be bedding-planes running north-north-east. Some distance further west, on the fall of the next gully, the ashes are seen to assume a very coarse character, with fragments about the size of an egg. Traced further north, these beds pass almost insensibly into what appears to be a medium-grained granite, the weathered surface of which is often pebbly, suggesting the probability of the granite being metamorphic. Near the summit of the ridge west of the Railway Station, the ashes contain lenticular lava-beds, the internal portions of which are wavy and contorted, looking very like fluxion-structure, but simulating the appearance put on by some rocks which have been subjected to intense pressure.

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\* Report on the Physical Geology of Magnetic Island, &c. By A. Gibb Maitland. Brisbane: by Authority: 1892.

Similar volcanic ashes and lava-beds extend from Stewart's Creek to Alligator Creek, and form Mount Louisa, Cape Pallarenda on the western extremity, and Cape Cleveland on the eastern extremity of Cleveland Bay, as well as the western corner of Magnetic Island.

The great thickness of alluvium which covers the stratified rocks north of the Aboriginal Reserve has hitherto formed an insuperable difficulty in the way of ascertaining whether workable coal-seams exist in the neighbourhood of Townsville. The site of the Caledonia Company's Bore is only about thirty-five feet above the sea-level, but the alluvium has been ascertained by numerous shallow bores in the vicinity to be from eighty to one hundred and ten feet in thickness.

A bore recently sunk by the Caledonia Coal Company, about half-a-mile south of the adit above referred to, gives the following section:—

	Ft.	in.
Surface ... ..	38	0
Sand and stones (water-bed) ... ..	20	0
Gravel and boulders... ..	28	0
Porphyry ... ..	4	0
Rough grey sandstone ... ..	8	0
Rough sandstone ... ..	6	0
Dark-brown sandstone ... ..	6	0
Coal ... ..	0	5
Sandstone and shales ... ..	2	6
Dark rock ... ..	5	0
Blue post (or lava) ... ..	17	0
Sandstone ... ..	5	0
Sandy shale with thin vein of coal ... ..	2	6
Conglomerate ... ..	17	0
Sandstone ... ..	1	0
Sandstone with vein of coal ... ..	0	6
Shales and sandstone ... ..	2	0
Conglomerate ... ..	17	3
Sandstone and shales ... ..	0	10
Shale with coal-veins ... ..	0	9
Sandstone and shale ... ..	1	0
Conglomerate ... ..	4	0
Fine conglomerate ... ..	1	4
Blue post (or lava) ... ..	1	3
Sandstone ... ..	8	0
Coal ... ..	0	11
Sandstone ... ..	1	0
Shales and sandstone with thin band of coal ... ..	4	6
Shale ... ..	1	0
Sandstone ... ..	4	0
Shale with thin band of coal ... ..	0	6
Sandstone ... ..	3	9
Shale ... ..	0	7
Conglomerate ... ..	2	6
Blue post (or lava) ... ..	3	0
Sandy shale ... ..	1	6
Blue post (or lava) ... ..	1	0
Sandstone ... ..	4	6
Sandy shale ... ..	1	3
Blue post (or lava) ... ..	44	2
Sandstone (brown, micaceous) ... ..	1	6
	273	0

Similar rocks were met with to about 350 feet, when hard quartzites and fine hard grits were met with, divided by bedding-planes forming an angle of about  $45^\circ$  to the perpendicular course of the bore. Apparently the base of the Coal-Measures had been reached, and an older formation, upon which they lie unconformably, entered upon.

In the neighbourhood of Cooktown a series of strata, presumably of the age of the Upper Bowen Formation, extends from the right bank of Oaky Creek, two miles above "Daddy's Camp," southward to the tributaries of Deep Creek, between the Byerstown Road and The Bluff—a distance of about six miles—with an average breadth of a mile and a-half. In this area of nine square miles a very considerable thickness of strata must be represented, as they generally dip at high angles. Sections on Oaky Creek show the base of this formation to rest unconformably on the older slates and quartzites, and at the south-east end of The Bluff the conglomerate and sandstones of the Normanby Range (Desert Sandstone) lie on the upturned edges of the strata of the coal-bearing formation. The strata consist for the most part of greenish-grey sandstones, dark-blue shales, and fireclays.

Between Oaky Creek and the Normanby Range, to the west, I found, in 1879, in Yam Creek and Coal Creek, numerous seams of coal, some of very good quality, but the thickest (in Coal Creek, twenty-five miles from Cooktown) was only eight inches.

A shaft was sunk on the eight-inch seam of coal, in 1879, by the Cooktown Railway League. The shaft went through the bottom of the coal to a total depth of nineteen feet. A drive six feet nine inches long was then made to the dip ( $33^\circ$ ), when the bottom of the coal was again cut. The seam was then followed down on the dip for fourteen feet six inches. At the north end of the vertical shaft the section was as follows:—

	In.	Ft.	in.
Black shales, with <i>Glossopteris</i> ... ..		17	2
First coal (good), 9 inches at upper side, 14 inches at lower side of shaft, with a parting of dark shale $2\frac{1}{2}$ inches thick at lower side, thinning out to $\frac{1}{4}$ -inch at upper side ...		1	2
Dark shale ... ..		0	$5\frac{1}{2}$
Second coal, impure, clayey, brittle, and short, light in colour. Fragments of anthracite can be picked from it ... ..	1	to 0	$2\frac{1}{2}$
Dark shale ... ..	4	to 0	5
Third coal, brittle anthracite ... ..	$4\frac{1}{2}$	to 0	5
Grey sandy shales ... ..		2	7
Hard grey sandstone ... ..		0	6
Sandy shale ... ..		1	6
Hard grey sandstone ... ..		0	$5\frac{1}{2}$

At the south end of the vertical shaft the section is as follows:—

	In.	Ft.	in.
Black shale ... ..			
First Coal { Coal, good ... ..	$2\frac{1}{2}$	to 0	3
{ Clay ... ..	0	to 0	1
{ Coal, good ... ..	6	to 0	9
Dark shale ... ..		0	$7\frac{1}{2}$
Second coal, brittle ... ..	$\frac{1}{2}$	to 0	1
Dark shale ... ..	$3\frac{1}{2}$	to 0	5
Third coal, brittle, anthracitic, impure ... ..	6	to 0	7
Dark sandy shale ... ..		2	7
Sandstone ... ..		0	6
Dark sandy shale ... ..		0	10
Sandstone (bottom of shaft)			

At the bottom of the underlie shaft the section is as follows:—

	In.	Ft.	in.
First Coal { Coal, good ... ..		0	3
Black shale ... ..	0	to	0 2
Coal, good ... ..	4	to	0 5
Black shale ... ..	4½	to	0 8
Second and third coals, brittle, anthracitic, 12 inches thick at end of shaft, although interrupted by 8 inches of shale			
2 feet from end ... ..		1	0

From the Oaky Creek beds my Colleague has recognised among my collection *Glossopteris linearis*, McCoy, and *Glossopteris ampla*, Dana. Silicified wood, very much resembling that from the Upper Bowen Formation, is also common.

The Little River Coal Field, near Palmerville, occurs in a somewhat peculiar position, having been wedged, by two faults, into the midst of an older series of greywackes, slates, quartzites, &c. After having been subjected to such a degree of lateral compression that its strata were inclined at high angles, it was covered over by a cake of Desert Sandstone. This cake was subsequently cut through by the Little River (a tributary of the Kennedy), exposing the Coal-Measures and older stratified rocks.

The coal-bearing strata consist mainly of blue and dark shales, gritty sandstones, and fireclays. The coal-seams are numerous and thick. One is twenty feet in thickness, another eighteen feet, two are eight feet each, two are six feet each, and four are three feet each; but all of these thick seams are of poor quality. They appear to have been, from the first, much mixed with muddy sediment, and to have had much of their volatile matter driven off by the pressure which resulted in the uptilting of the beds.

An eight-feet seam on the bank of the Little River, near Bowerbird Gully, was analysed by the late Mr. Karl Staiger as follows:—

Moisture, with a little gas ... ..	18.32
Carbon ... ..	66.94
Ash ... ..	15.74
	<hr/>
	100.00

I analysed samples from an eight-feet seam on Dave Creek, with the following result:—

Water ... ..	0.919
Volatile hydrocarbons... ..	9.388
Fixed carbon ... ..	58.606
Ash ... ..	31.087
	<hr/>
	100.00

Specific gravity, 1.37.

Near the junction of the Little River with the St. George River the following section is seen:—

	Ft.	in.
Coal, good ... ..	0	7
Dark-grey shales ... ..	0	6
Coal, good ... ..	0	7
Dark shales ... ..	1	0
Decomposed carbonaceous ironstone ... ..	0	3
Coal, fair ... ..	0	7
Grey shales ... ..	0	4
Dark gnarled shales ... ..	0	3
Grey shales and sandstones, with a few bands of oolitic ironstone (1 to 2 inches), and impressions of fossil trees ... ..	20	0

This coal, on analysis, gave much better results than any of the thicker seams; in fact, it is one which, if of workable thickness, would take a high place among coals used for steam and smelting purposes. The following is the analysis:—

Water	...	...	...	...	...	...	2.763
Volatile hydrocarbons	...	...	...	...	...	...	26.197
Fixed carbon	...	...	...	...	...	...	62.998
Ash	...	...	...	...	...	...	8.042

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100.00

Specific gravity, 1.32.

The only fossil from the Little River determined by my Colleague is *Glossopteris Browniana*, Brong.

If the evidence for the Palæozoic age of the Oaky Creek and Little River deposits rested solely on the presence of *Glossopteris*, it would be of little value, seeing that *Glossopteris* has been detected in beds as new as the Desert Sandstone; but in the cases before us, the coal-bearing beds are not only upturned, but are covered unconformably by the Desert Sandstone itself.

In "Notes on the Geology of Hann's Exploring Expedition,"\* with which Mr. Norman Taylor has obligingly furnished me, the following passages occur:—"At Camp 16, on the Mitchell River (Camp 78 on the return journey), I found in the river-bed fragments and blocks of coal shales, with thin seams of bright coal, and on searching carefully I discovered pieces of a whitish indurated shale, containing indistinct plant-remains and an undoubted fragment of *Glossopteris*. (The shales are identical with some in the Blue Mountains of New South Wales, north of Wallerawang, and again at Tallawang, north of Gulgong.)" . . . "About a mile south of this camp is a low table-topped rise, consisting of horizontal white and grey shales and a cherty-looking rock, with fragments and stems of plants and traces of *Glossopteris in situ*. This rests on porphyry, which forms a series of rocky hills two miles further south, extending seven miles south-easterly to the foot of and overlooking some high table-topped Carboniferous ranges (composed of sandstones, grits, and conglomerates, with silicified wood) in that direction."

The occurrence of *Glossopteris* alluded to by Mr. Taylor has always been a puzzle to me. It would appear as if the plant had been found in the horizontal sandstones and shales, which I have always regarded as of Desert Sandstone age, and on this evidence, in my "Handbook of Queensland Geology" (1886), and "Geological Map of Queensland" (1886), I classed the Mount Mulligan Tableland as a continuation of Mr. Taylor's "Carboniferous Range," I confess with considerable reluctance. Since then, however, Mr. Rands' discovery of *Glossopteris* in a portion of the Desert Sandstone, which clearly overlies unconformably the Lower Cretaceous Rolling Downs Formation, removes any difficulty there may have been in regarding Mr. Taylor's *Glossopteris*-bearing beds as of Desert Sandstone age, and I have restored them accordingly to that formation in the Geological Map issued herewith.

J.

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\* For a full account of the late Mr. W. Hann's Exploring Expedition in Northern Queensland (to which Mr. Norman Taylor was attached as Geologist), see *Proc. R. Geogr. Soc.*, 1874, xviii., pp. 87-107.

## CHAPTER XX.

### THE PERMO-CARBONIFEROUS SYSTEM—*continued*.

#### LIFE OF THE UPPER BOWEN FORMATION.

THE fossils occurring in the Upper Bowen River Formation are:—*Phyllothea australis*, Brong., *Sphenopteris lobifolia*, Morris, *S. flexuosa*, McCoy, *S. crebra*, Ten. Woods, *Glossopteris Browniana*, Brong., *G. linearis*, McCoy, Coniferous wood, *Derbyia senilis*, Phill., *Productus brachythærus*, G. Sby., and *Goniatites, sp. ind.*, Pl. 15, fig. 5.

Of these, *Phyllothea australis*, *Sphenopteris flexuosa*, and *S. crebra*, are peculiar to this formation.

*Productus brachythærus* occurs not only in this formation but also in the Gympie and Middle Bowen Formations.

*Sphenopteris lobifolia*, *Glossopteris Browniana*, *G. linearis*, and *Derbyia senilis*, occur in both the Middle and Upper Bowen Formations.

*Goniatites, sp. ind.*, Pl. 15, fig. 5, occurs in both the Upper Bowen and the Gympie Formations.

The following Genera are common to the Upper Bowen and Gympie Formations:—MOLLUSCA: *Productus* and *Goniatites*.

There are not even any genera common to the Upper Bowen and Star Formations.

The following Genera are common to the Upper and Middle Bowen Formations:—PLANTÆ: *Sphenopteris* and *Glossopteris*. MOLLUSCA: *Derbyia*, *Productus*, and *Goniatites*.

J.

# CHAPTER XXI.

## LIST OF THE FOSSILS OF THE PERMO-CARBONIFEROUS SYSTEM, SHOWING THEIR HORIZONS.

### NOTES.

- The Gympie Series (Column I.) includes, besides the Gympie area (G.), the following :—"Rockhampton District" (R.), Lake's Creek and Training Wall Quarries (L.), Kooingal (K.), Stanwell, in part (S.), Encrinite Creek (E.), Fenestella Hill (F.), Athelstane Range (A.), Don River (D.), Crow's Nest (C.), Blackfellow's Diggings (B.), Lilymere (LM.), Kariboe Creek, Cania (KC.), Yatton (Y.), Yarrol Limestone (YL.), Hodgkinson Gold Field (H.), Raglan\* (RL.), Beaconsfield (BF.), Langmorn (LR.), Broomsound Ranges (BR.), Apis Creek (AC.)
- The Star Beds (Column II.) include, besides the Star area (S.), the following :—Keelbottom (K.), Drummond (D.), Mount Wyatt (W.), Canoona (C.), Broken River (B.)
- The Middle or Marine Series (Column III.) includes, besides the Middle Series as developed on the Bowen River (MB.), the following :—Cracow Creek, in part (C.), Dawson River, in part (D.), Mount Britton (B.), Stanwell, in part (S.), Banana Creek (BC.), Springsure (SS.)
- The Upper or Freshwater Series (Column IV.) includes, besides the Upper Series as developed on the Bowen River (UB.), the following :—Cracow Creek, in part (C.), Dawson River, in part (D.), Little River, Cooktown (L.), Oakley Creek, Cooktown (O.), Stewart's Creek, Townsville (S.), Walker's Creek, Nebo (W.), and Dinner Creek, Stanwell (DC.)

Systematic Position and Name.	I. Gympie Series.	II. Star Beds.	III. Middle or Marine Series— Bowen River Coal Field.	IV. Upper or Freshwater Series— Bowen River Coal Field.
Kingdom—PLANTÆ. Section—CRYPTOGAMIA. Class—ACOTYLEDONES. Order—CALAMARIA. Family—EQUISETACEÆ. Genus—CALAMITES.				
<i>Calamites varians</i> , Germar. ... ..	...	D		
" " <i>sp. ind.</i> ... ..	L			
Genus—ASTEROCALAMITES.				
<i>Asterocalamites scrobiculatus</i> , Schloth., Pl. 4, figs. 11, 12	...	D		
Family—SCHIZONEURIDÆ. Genus—PHYLLOTHECA.				
<i>Phyllothea australis</i> , Brong. ... ..	...	...	...	UB
Order—FILICES. Family—SPHENOPTERIDÆ. Genus—SPHENOPTERIS.				
<i>Sphenopteris lobifolia</i> , Morris ... ..	...	...	C, ? MB	UB
<i>fleuosa</i> , McCoy ... ..	...	...	...	D
<i>crebra</i> , Ten. Woods... ..	...	...	...	D
Family—PALÆOPTERIDÆ. Genus—ANEIMITES.				
<i>Aneimites austrina</i> , Eth. fil. ... ..	...	D		

\* I regard this as Devonian. See Footnote, p. 89. (R.E. Junr.)



## LIST OF FOSSILS OF THE PERMO-CARBONIFEROUS SYSTEM—continued.

Systematic Position and Name.	I. Gympie Series.	II. Star Beds.	III. Middle or Marine Series— Bowen River Coal Field.	IV. Upper or Freshwater Series— Bowen River Coal Field.
Family— <b>DICTYOTENIOPTERIDÆ.</b>				
Genus— <b>GLOSSOPTERIS</b>				
<i>Glossopteris Browniana</i> , Brong., Pl. 16, figs. 6, 8; Pl. 17, figs. 9, 10	...	...	MB	UB, D, O, L, S, W, DC
" <i>linearis</i> , McCoy	...	...	MB	O, UB
" <i>ampia</i> , Dana ? Pl. 16, fig. 7	...	...	P MB	
Order— <b>LYCOPODIACEÆ.</b>				
Family— <b>LEPIDODENDRIDÆ.</b>				
Genus— <b>LEPIDODENDRON</b>				
<i>Lepidodendron australe</i> , McCoy, Pl. 5, figs 1-10	...	L, H	S, W, C, B, D	
" <i>veltheimianum</i> , Sternb.	...	...	D	
" <i>sp. ind.</i> , Pl. 6, figs. 1, 4	...	...	S, D	
Genus— <b>CYCLOSTIGMA.</b>				
<i>Cyclostigma australe</i> , Feist.	...	...	D	
" <i>sp.</i> , Feist., allied to <i>C. Killbuckense</i>	...	...	W, C	
Genus— <b>STIGMARIA.</b>				
<i>Stigmaria, sp. ind.</i> , Ten. Woods	...	...	D	
Section— <b>PHANEROGAMIA.</b>				
Class— <b>DICOTYLEDONES.</b>				
Order— <b>CYCADACEÆ.</b>				
Family— <b>CORDAITES.</b>				
Genus— <b>CORDAITES.</b>				
<i>Cordaites australis</i> , McCoy ?	...	?	D	
Order— <b>CONIFERÆ</b>	...	...	MB	UB
Kingdom— <b>ANIMALIA.</b>				
Sub-Kingdom— <b>PROTOZOA.</b>				
Class— <b>SPONGIDA.</b>				
Order— <b>MONACTINELLIDÆ.</b>				
Family— <b>?</b>				
Genus— <b>LASIOCLADIA.</b>				
<i>Lasiocladia ? Hindei</i> , Eth. fl., Pl. 41, figs. 1, 2	...	R		
Sub-Kingdom— <b>COELENTERATA.</b>				
Class— <b>ACTINOZOA.</b>				
Order— <b>RUGOSA.</b>				
Group— <b>ZAPHRENTOIDEA.</b>				
Family— <b>ZAPHRENTIDÆ.</b>				
Genus— <b>ZAPHRENTIS.</b>				
<i>Zaphrentis profunda</i> , Eth. fl., Pl. 44, fig. 1	...	R		
Group— <b>CYATHOPHYLLOIDEA.</b>				
Family— <b>CYATHOPHYLLIDÆ.</b>				
Genus— <b>CYATHOPHYLLUM.</b>				
<i>Cyathophyllum, sp. ind.</i> , Pl. 3, f. 10	...	...	BP	
" <i>sp. ind.</i> , Pl. 7, f. 1	...	...	LB	

LIST OF FOSSILS OF THE PERMO-CARBONIFEROUS SYSTEM—*continued.*

Systematic Position and Name.	I. Gymple Series.	II. Star Beds.	III. Middle or Marine Series— Bowen River Coal Field.	IV. Upper or Freshwater Series— Bowen River Coal Field.
Section—PERFORATA. Family—AULOPORIDÆ. Genus—CLADOCHONUS. <i>Cladochonus tenuicollis</i> , McCoy ... ..	R			
Order—MONTICULIPOREIDA. Family—MONTICULIPOREIDÆ. Genus—MONTICULIPORA. <i>Monticulipora</i> , <i>sp. ind.</i> , Pl. 38, figs. 1, 2 ... ..	K			
Genus—STENOPORA. <i>Stenopora australis</i> , Nich. and Eth. fl., Pl. 6, figs. 5-8 ... ..	...	...	MB	
" <i>Leichhardtii</i> , Nich. and Eth. fl., Pl. 6, figs. 9, 10; Pl. 7, fig. 2 ... ..	...	...	MB	
" <i>Jackii</i> , Nich. and Eth. fl., Pl. 6, figs. 11-13 ... ..	...	...	MB	
" <i>sp. ind.</i> , Pl. 7, figs. 3-5 ... ..	K			
" <i>gimpiensis</i> , Eth. fl., Pl. 6, figs. 14, 15 ... ..	G			
Sub-Kingdom—ECHINODERMATA. Section—PELMATOZOA. Class—CRINOIDEA. Order—COADUNATA. Family—ACTINOCRINIDÆ. Genus—ACTINOCRINUS. <i>Actinocrinus</i> , <i>sp. ind.</i> , Pl. 7, fig. 9 ... ..	R	S		
Family—PLATYCRINIDÆ. Genus—PLATYCRINUS. <i>Platycrinus ? nux</i> , Eth. fl., Pl. 38, fig. 3 ... ..	...	...	B	
Order—INADUNATA. Family—POTERIOCRINIDÆ. <i>Cup of Crinoid</i> , Pl. 44, fig. 7 ... ..	R			
<i>Poteriocrinus ? Smithii</i> , Eth. fl., Pl. 8, fig. 1 ... ..	S			
" <i>crassus</i> , Miller ? Pl. 7, fig. 6 ... ..	R, F			
<i>Arms of Crinoid</i> , Pl. 7, fig. 7 ... ..	S			
" " Pl. 7, fig. 8 ... ..	S			
<i>Impressions of Crinoid Calyx</i> , Pl. 44, fig. 8 ... ..	R			
<i>Crinoid Stems</i> ... ..	K, S, A	...	SS	
Class—BLASTOIDEA. Order—REGULARES. Family—PENTREMITIDÆ. Genus—MESOBLASTUS. <i>Mesoblastus ? australis</i> , Eth. fl., Pl. 44, fig. 2 ... ..	R			
Family—GRANATOBLASTIDÆ. Genus—GRANATOCRINUS. <i>Granatocrinus ? Wachsmuthi</i> , Eth. fl., Pl. 7, fig. 10 ... ..	S			
Family—TROOSTOBLASTIDÆ. Genus—TRICLOCRINUS. <i>Triclocrinus ? Carpenteri</i> , Eth. fl., Pl. 44, fig. 3 ... ..	R			
Section—ECHINOZOA Class—ECHINOIDEA. Order—PALECHINOIDEA. Family—ARCHÆOCIDARIDÆ. Genus—ARCHÆOCIDARIS. <i>Archæocidaris</i> , <i>sp.</i> .. ...	R			

## LIST OF FOSSILS OF THE PERMO-CARBONIFEROUS SYSTEM—continued.

Systematic Position and Name.	I. Gympie Series.	II. Star Beds.	III. Middle or Marine Series— Bowen River Coal Field.	IV. Upper or Freshwater Series— Bowen River Coal Field.
Sub-Kingdom— <b>ANNULOSA.</b>				
Class— <b>CRUSTACEA.</b>				
Order— <b>OSTRACODA.</b>				
Family— <b>LEPERDITIDÆ.</b>				
Genus— <b>BEYRICHIA.</b>				
<i>Beyrichia varicosa</i> , T. R. Jones, Pl. 7, fig. 15 ...	...	S		
Order— <b>TRILOBITA.</b>				
Family— <b>PRETIDÆ.</b>				
Genus— <b>PHILLIPSTIA.</b>				
<i>Phillipstia dubia</i> , Eth., Pl. 7, fig. 12; Pl. 8, figs. 5, 6; Pl. 44, fig. 4	D	S		
" <i>Woodwardi</i> , Eth. fil., Pl. 7, figs. 11, 13; Pl. 8, fig. 6; Pl. 44, figs. 5, 6	S			
" ? <i>sp. ind.</i> ...	C			
Genus— <b>GRIFFITHIDES.</b>				
<i>Griffithides seminifera</i> , Phill ? , Pl. 7, fig. 14 ...	S, B			
Sub-Kingdom— <b>MOLLUSCA.</b>				
Section— <b>MOLLUSCOIDEA.</b>				
Class— <b>POLYZOA.</b>				
Order— <b>GYMNOLEMATA.</b>				
Sub-Order— <b>CYCLOSTOMATA.</b>				
Family— <b>FENESTELLIDÆ.</b>				
Genus— <b>FENESTELLA.</b>				
<i>Fenestella fossula</i> , Lonsd., Pl. 9, figs. 4, 5 ...	G, B, L	...	MB	
" <i>internata</i> , Lonsd., Pl. 9, figs. 6, 7 ...	F			
" <i>sp. ind.</i> ...	G, K			
" <i>multiopata</i> , De Kon. Pl. 8, figs. 7, 8 ...	...	S		
Genus— <b>POLYPORA.</b>				
<i>Polypora</i> ? <i>Smithii</i> , Eth. fil., Pl. 9, figs. 1-3; ? Pl. 44, figs. 9, 10.	B, F, G			
Genus— <b>PROTORRETEPORA.</b>				
<i>Protoretepora ampla</i> , Lonsd. ...	B, G, BR, AC			
" " var. <i>Woodsi</i> , Eth. fil., Pl. 8, fig. 12	...	...	MB	
" " var. <i>Konincki</i> , Eth. fil. ...	...	...	MB	
Family— <b>THAMNISCIDÆ.</b>				
Genus— <b>GLAUCONOME.</b>				
<i>Glaucome</i> , <i>sp. ind.</i> , Pl. 44, fig. 11 ...	B			
Family— <b>PETALOPORIDÆ.</b>				
Genus— <b>RHOMBOPORA.</b>				
<i>Rhombopora</i> ? <i>laxa</i> , Eth., Pl. 9, figs. 8, 9 ...	G, S			
Family—				
Genus— <b>MYRIOLITHES.</b>				
<i>Myriolithes</i> ? <i>queenslandensis</i> , Eth. fil. ...	LM, RL*			
Class— <b>BRACHIOPODA.</b>				
Order— <b>TRETENTRATA.</b>				
Family— <b>TEEBERATULIDÆ.</b>				
Genus— <b>DIELASMA.</b>				
<i>Dielasma cymbæformis</i> , Morris, Pl. 9, figs. 10, 11 ...	...	...	MB	

\* I regard this as Devonian. See Footnote, p. 89. (R.E. Junr.)

## LIST OF FOSSILS OF THE PERMO-CARBONIFEROUS SYSTEM—continued.

Systematic Position and Name.	I. Gympie Series.	II. Star Beds.	III. Middle or Marine Series— Bowen River Coal Field.	IV. Upper or Freshwater Series— Bowen River Coal Field.
<i>Dielasma sacculus</i> , Martin, var. ... ..	...	...	BC	
" " var. <i>kastata</i> , J. de C. Sby. ... ..	B			
" <i>sp. ind.</i> , Pl. 40, figs. 1, 2 ... ..	B			
Family--SPIRIFERIDÆ.				
Genus--SPIRIFERA.				
<i>Spirifera striata</i> , Martin? Pl. 9, fig. 16 ... ..	...	...	MB	
" <i>sp. int. (a.)</i> , Pl. 9, fig. 12 ... ..	D, B			
" <i>vespertilio</i> , G. B. Sby., Pl. 10, fig. 8 ... ..	G, S			
" <i>concoluta</i> , Phill., Pl. 10, figs. 10, 11 ... ..	...	...	MB	
" <i>lata</i> , McCoy ... ..	Y	...	BC	
" <i>Clarkei</i> , De Kon. Pl. 10, fig. 16? ... ..	...	...	MB	
" <i>trigonalis</i> , Martin, Pl. 9, fig. 15 ... ..	B	...	MB	
" " var. <i>acuta</i> , Eth., Pl. 10, fig. 12 ... ..	G			
" " var. <i>crassa</i> , De Kon., Pl. 11, fig. 5 ... ..	S			
" <i>dubia</i> , Eth., Pl. 10, fig. 14 ... ..	G			
" <i>sp. ind. (b.)</i> , Pl. 88, figs. 4-6 ... ..	...	...	B	
" <i>tasmaniensis</i> , Morris, Pl. 10, figs. 1, ? 15 ... ..	...	...	MB, BC	
" <i>Stokesii</i> , König, Pl. 10, figs. 2-4 ... ..	G, Y	...	BC, B	
" <i>pinguis</i> , J. Sby. ... ..	B			
" <i>bicarinata</i> , Eth. fl., Pl. 10, figs. 9, 13; Pl. 37, fig. 17; Pl. 11, figs. 1-3 ... ..	S, KC	S, K		
" <i>Strzeleckii</i> , De Kon., Pl. 10, figs. 5-7 ... ..	G	...	? B	
Genus--SPIRIFERINA.				
<i>Spiriferina duodecimcostata</i> , McCoy, Pl. 44, fig. 12 ... ..	...	...	B	
" <i>sp. ind.</i> ... ..	...	S		
Genus--RETICULARIA.				
<i>Reticularia lineata</i> , Martin? ... ..	B			
" <i>Urei</i> , Fleming ... ..	...	S		
Genus--MARTINIA.				
<i>Martinia? productoides</i> , Eth. fl., Pl. 11, figs. 6-11 ... ..	L, S, KC			
Genus--MARTINIOPSIS.				
<i>Martiniopsis? subradiata</i> , G. B. Sby., Pl. 11, fig. 14 ... ..	G	...	MB, BC, B	
" <i>subradiata</i> , var. <i>Morrisii</i> , Eth. fl., Pl. 11, figs. 12, 13? ... ..	KC			
" <i>Darwini</i> , Morris, Pl. 9, figs. 13, 14; Pl. 39, figs. 5-7 ... ..	Y	...	MB, B	
Family--NUCLEOSPIRIDÆ.				
Genus--RETZIA.				
<i>Retzia radialis</i> , Phill., Pl. 11, figs. 24, 25 ... ..	...	S		
" <i>lilymerensis</i> , Eth. fl., Pl. 11, figs. 20-22 ... ..	LM			
Family--ATHYRIDÆ.				
Genus--ATHYRIS.				
<i>Athyris Roysii</i> , Leveillé, Pl. 11, fig. 15 ... ..	S			
" <i>ambigua</i> , J. de C. Sby. ... ..	KC			
" <i>Randsi</i> , Eth. fl., Pl. 11, figs. 16-18 ... ..	KC			
Family--RHYNCHONELLIDÆ.				
Genus--RHYNCHONELLA.				
<i>Rhynchonella pleurodon</i> , Phill., Pl. 11, fig. 23 ... ..	S	K		
" <i>sp. ind.</i> ... ..	KC			

## LIST OF FOSSILS OF THE PERMO-CARBONIFEROUS SYSTEM—continued.

Systematic Position and Name.	I. Gympie Series.	II. Star Beds.	III. Middle or Marine Series— Bowen River Coal Field.	IV. Upper or Freshwater Series— Bowen River Coal Field.
Family—ORTHIDÆ. Genus—ORTHIS.				
<i>Orthis resupinata</i> , Martin, Pl. 11, figs. 26, 28 ... ..	S, A, KO	S		
„ <i>australis</i> , McCoy, Pl. 11, figs. 27, 29 ... ..	S, R			
Family—STROPHOMENIDÆ. Genus—STROPHOMENA.				
<i>Strophomena rhomboidalis</i> , var. <i>analoga</i> , Phill., Pl. 12, figs. 8, 9; Pl. 40, fig. 6	G, B	S		
Genus—DERBYIA.				
<i>Derbyia senilis</i> , Phill. ... ..	...	...	MB	UB
Family—PRODUCTIDÆ. Genus—PRODUCTUS.				
<i>Productus cora</i> , D'Orb., Pl. 12, fig. 14; Pl. 13, fig. 1; Pl. 38, fig. 11	G, S, L	...	B	
„ <i>brachytharus</i> , G. Sby., Pl. 12, figs. 10-13; Pl. 13, fig. 5?; Pl. 44, fig. 14	F, E, S, KC, YL	...	MB, B	UB
„ <i>subquadratus</i> , Morris, Pl. 38, figs. 7-10; Pl. 40, fig. 5.	L, Y	...	MB, B	
„ <i>undatus</i> , DeFrance, Pl. 12, fig. 16 ... ..	S			
„ <i>semireticulatus</i> , Martin? ... ..	S, KO			
„ <i>longispinus</i> , J. Sby.? ... ..	D			
„ <i>sp. ind. (a.)</i> , Pl. 13, fig. 6 ... ..	YL			
„ <i>sp. ind. (b.)</i> , Pl. 12, fig. 15 ... ..	S			
„ <i>sp. ind. (c.)</i> , Pl. 13, fig. 4 ... ..	S			
„ <i>sp. ind. (d.)</i> , Pl. 40, fig. 4 ... ..	B			
„ <i>sp. ind. (e.)</i> , Pl. 37, fig. 18 ... ..	...	...	B	
„ <i>sp. ind. (f.)</i> , Pl. 44, fig. 13 ... ..	Y			
Genus—STROPHALOSIA.				
<i>Strophalosia Clarkei</i> , Eth., Pl. 13, figs. 12-17; Pl. 14, fig. 19	...	...	MB, SS	
„ <i>Gerardi</i> , King, Pl. 13, fig. 18; Pl. 14, fig. 18; Pl. 40, figs. 7, 8	...	...	MB, BC	
Genus—CHONETES.				
<i>Chonetes cracowensis</i> , Eth., Pl. 13, fig. 9 ... ..	A	S	C	
„ <i>sp. ind. (a.)</i> , Pl. 13, fig. 10; Pl. 37, figs. 21, 22	...	S, K		
„ <i>sp. ind. (b.)</i> , Pl. 13, figs. 7, 8, 13 ... ..	A, S			
„ <i>sp. ind. (c.)</i> , Pl. 37, fig. 20 ... ..	...	K		
„ <i>sp. ind. (d.)</i> , Pl. 37, fig. 19 ... ..	...	...	B	
Order—CLISTENTERATA. Family—LINGULIDÆ. Genus—LINGULA.				
<i>Lingula mytiloides</i> , J. Sby.? Pl. 13, fig. 19 ... ..	KC			
Section—MOLLUSCA VERA. Class—PELEGYPODA. Order—OSTRACEA. Family—PECTINIDÆ. Genus—ENTOLIUM.				
<i>Entolium, sp.</i> ... ..	...	S		
Genus—EUCHONDRIA.				
<i>Euchondria, sp.</i> ... ..	...	S		

## LIST OF FOSSILS OF THE PERMO-CARBONIFEROUS SYSTEM—continued.

Systematic Position and Name.	I. Gympie Series.	II. Star Beds.	III. Middle or Marine Series— Bowen River Coal Field.	IV. Upper or Freshwater Series— Bowen River Coal Field.
Family—AVICULOPECTINIDÆ. Genus—AVICULOPECTEN.				
<i>Aviculopecten subquinguelineatus</i> , McCoy ... ..	...	..	MB	
" <i>lunaformis</i> , Morris? Pl. 14, fig. 1 .. ..	? G, ? Y	...	MB	
" <i>imbricatus</i> , Eth. . . . .	G			
" <i>multiradiatus</i> , Eth. . . . .	X, G			
" <i>Laurenti</i> , Eth. fl., Pl. 43, figs. 3, 4 ... ..	C, B			
Genus—DELTOPECTEN.				
<i>Deltopecten illawarrensis</i> , Mor., Pl. 41, fig. 3; Pl. 43, fig. 2	...	...	B	
Genus—PTERINOPECTEN.				
<i>Pterinopecten Decisii</i> , Eth. fl., Pl. 40, fig. 9 .. ..	B			
Order—MYTILACEA. Family—AVICULIDÆ. Genus—MERISMOPTERIA.				
<i>Merisopteria macroptera</i> , Mor. . . . .	...	...	MB	
Family—MYTILIDÆ. Genus—MYTILOPS.				
<i>Mytilops ? corrugata</i> , Eth. fl., Pl. 40, fig. 11 ... ..	B			
" <i>? sp. ind.</i> , Pl. 14, fig. 20 ... ..	G			
Genus—MODIOMORPHA.				
<i>Modiomorpha ? Daintreei</i> , Eth. fl., Pl. 14, fig. 13 ... ..	KC			
" <i>mytiliformis</i> , Eth. fl., Pl. 14, fig. 5; Pl. 40, fig. 4	.	...	BC, B	
Order—ARCEA. Family—ARCIDÆ. Genus—PARALLELODON.				
<i>Parallelodon costellata</i> , McCoy, Pl. 40, figs. 12, 13 .. ..	B			
Family—NUCULIDÆ. Genus—NUCULA.				
<i>Nucula, sp. ind.</i> , Pl. 40, fig. 10 .. .. .	B			
Family—NUCULANIDÆ. Genus—NUCULANA.				
<i>Nuculana, sp. ind.</i> , Pl. 14, fig. 17... .. .	...	B		
Order—LUCINACEA. Family—SOLEMYIDÆ. Genus—SOLEMYA.				
<i>Solemys Edelfelti</i> , Eth. fl., Pl. 14, fig. 16 ... ..	...	...	MB	
Family—ASTARTIDÆ. Genus—PLEUROPHORUS.				
<i>Pleurophorus Randei</i> , Eth. fl., Pl. 14, fig. 14 .. ..	YL			
Genus—ASTARTELLA.				
<i>Astartella rhomboides</i> , Eth. fl., Pl. 14, fig. 15	G			
Genus—CYPRICARDILLA.				
<i>Cypricardella Jackii</i> , Eth. fl., Pl. 14, figs. 11, 12 .. ..	G			
Genus—ASTARTILA.				
<i>Astartila cytherea</i> , Dana, Pl. 14, figs. 3, 4 .. ..	...	...	MB	

LIST OF FOSSILS OF THE PERMO-CARBONIFEROUS SYSTEM—*continued*.

Systematic Position and Name.	I. Gympie Series.	II. Star Beds.	III. Middle or Marine Series— Bowen River Coal Field.	IV. Upper or Freshwater Series— Bowen River Coal Field.
Order—CHAMACEA.				
Family—TRIDACNIDÆ.				
Genus—EURYDESMA.				
<i>Eurydesma cordata</i> , Morris ... ..	Y			
„ <i>sacculus</i> , McCoy ... ..	Y			
Order—VENERACEA.				
Family—CARDIIDÆ.				
Genus—CONOCARDIUM.				
<i>Conocardium australe</i> , McCoy, Pl. 14, fig. 6 ... ..	G			
Order—MYACEA.				
Family—ANATINIDÆ.				
Genus—CHENOMYA.				
<i>Chenomya</i> ? <i>Etheridgei</i> , De Kon. ... ..	? G	...	BC	
„ ? <i>carinata</i> , Eth. fil., Pl. 43, figs. 5, 6 ... ..	...	...	BC	
„ ? <i>acuta</i> , Eth. ... ..	...	...	MB	
„ ? <i>bowenensis</i> , Eth. fil. ... ..	...	...	MB	
Genus—EDMONDIA.				
<i>Edmondia</i> ? <i>obovata</i> , Eth.... ... ..	G			
Genus—SANGUINOLITES.				
<i>Sanguinolites concentricus</i> , Eth., Pl. 43, fig. 7 ... ..	G			
Family—SAXICAVIDÆ.				
Genus—PACHYDOMUS.				
<i>Pachydomus globosus</i> , J. de C. Sby. ... ..	...	...	MB	
Genus—MÆONIA.				
<i>Mæonia carinata</i> , Mor. ... ..	...	...	MB	
„ <i>recta</i> , Dana ... ..	...	...	MB	
Class—GASTEROPODA.				
Order—PROSOBRANCHIATA.				
Family—NATICIDÆ.				
Genus—NATICOPSIS.				
<i>Naticopsis</i> ? <i>harpæformis</i> , Eth., Pl. 5, fig. 10 ... ..	D			
„ <i>variata</i> , Phill. ? ... ..	...	S		
„ <i>sp. ind.</i> ... ..	...	S		
Family—PYRAMIDELLIDÆ.				
Genus—LOXONEMA.				
<i>Loxonema, sp.</i> ... ..	S			
Family—EUOMPHALIDÆ.				
Genus—EUOMPHALUS.				
<i>Euomphalus, sp.</i> ... ..	S			
Genus—PLATYSCHISMA.				
<i>Platyschisma oculus</i> , J. de C. Sby., Pl. 15, figs. 3, 4 ... ..	S			
„ <i>rotunda</i> , Eth., Pl. 15, fig. 6 ... ..	R	...	C	
Family—PLEUROTOMARIIDÆ.				
Genus—PLEUROTOMARIA.				
<i>Pleurotomaria carinata</i> , J. de C. Sby., Pl. 15, fig. 16 ... ..	G			
Genus—MOURLONIA.				
<i>Mourlonia Strzeleckiana</i> , Mor., Pl. 15, fig. 2 ... ..	LM, XL			
„ ? <i>coniformis</i> , Eth. fil., Pl. 41, fig. 5 ... ..	...	...	BC	

LIST OF FOSSILS OF THE PERMO-CARBONIFEROUS SYSTEM—*continued*.

Systematic Position and Name.	I. Gympie Series.	II. Star Beds.	III. Middle or Marine Series— Bowen River Coal Field.	IV. Upper or Freshwater Series— Bowen River Coal Field.
Genus—YVANIA.				
<i>Yvania Konincki</i> , Eth. fil., Pl. 41, fig. 7 ... ..	R			
Genus—LUCIELLA.				
<i>Luciella</i> ? <i>Grayæ</i> , Eth. fil., Pl. 41, fig. 6 ... ..	R			
Genus—MURCHISONIA.				
<i>Murchisonia carinata</i> , Eth., Pl. 15, fig. 9 ... ..	D			
„ <i>sp. (a)</i> ... ..	R			
„ <i>sp. (b)</i> ... ..	R			
„ <i>sp. (c)</i> ... ..	R			
Family—BELLEROPHONTIDÆ.				
Genus—BELLEROPHON.				
<i>Bellerophon stancellensis</i> , Eth. fil., Pl. 15, figs. 11-13	S	...	BO	
Genus—BUCANIA.				
<i>Bucania textilis</i> , De Kon., Pl. 41, fig. 8 ... ..	R			
Genus—PORCELLIA.				
<i>Porcellia Pearsi</i> , Eth. fil., Pl. 15, figs. 7, 8 ... ..	R	S	BO	
Class—PTEROPODA.				
Order—THECOSOMATA.				
Family—CONULARIIDÆ.				
Genus—CONULARIA.				
<i>Conularia tenuistriata</i> , McCoy ... ..	G			
„ <i>sp. ind.</i> , Pl. 41, fig. 10 ... ..	G			
Class—CEPHALOPODA.				
Order—TETRABRANCHIATA.				
Family—NAUTILIDÆ.				
Genus—NAUTILUS.				
<i>Nautilus, sp.</i> ... ..	R			
„ ? <i>ammonitiformis</i> , Eth. fil., Pl. 39, fig. 9; Pl. 41, fig. 9 ... ..	R			
Family—ORTHOCERATIDÆ.				
Genus—ORTHOCERAS.				
<i>Orthoceras, sp.</i> ... ..	G, R	S	B	
Genus—GYROCERAS.				
<i>Gyroceras dubius</i> , Eth. fil., Pl. 41, fig. 12 ... ..	R			
Family—GONIATITIDÆ.				
Genus—GONIATITES.				
<i>Goniatites micromphalus</i> , Mor. ... ..	...	...	MB	
„ <i>sp. ind.</i> , Pl. 15, fig. 5 ... ..	G	...	...	UB *
„ <i>planorbiformis</i> , Eth. fil., Pl. 41, fig. 9 ... ..	L, R			
„ <i>sp. ind.</i> , Pl. 15, figs. 14, 15 ... ..	L, KC			
Sub-Kingdom—VERTEBRATA.				
Class—PISCES.				
Order—CHONDROPTERYGII.				
Family—COCHLIODONTIDÆ.				
Genus—DELTODUS.				
<i>Deltodus ? australis</i> , Eth. fil., Pl. 39, fig. 11 ... ..	R			
Order—GANOIDEI.				
Family—PALEONISCIDÆ.	...	S, D		
Genus—PALEONISCUS.				
<i>Paleoniscus Randsi</i> , Eth. fil.				



## SYNOPSIS.

**The Gympie Beds contain—**

95 species peculiar to themselves.

12 „ in common with the Star Beds.

17 „ „ „ Middle Series of the Bowen River Coal Field.

2 „ „ „ Upper „ „ „

**The Star Beds contain—**

19 species peculiar to themselves.

12 „ in common with the Gympie Beds.

3 „ „ „ Middle Series of the Bowen River Coal Field.

**The Middle Series of the Bowen River Coal Field contains—**

34 species peculiar to itself.

17 „ in common with the Gympie Beds.

12 „ „ „ Star Beds.

6 „ „ „ Upper Series of the Bowen River Coal Field.

**The Upper Series of the Bowen River Coal Field contains—**

3 species peculiar to itself.

2 „ in common with the Gympie Beds.

6 „ „ „ Middle Series of the Bowen River Coal Field.

**J.**

## CHAPTER XXII.

### THE ORGANIC REMAINS OF THE PERMO-CARBONIFEROUS SYSTEM.

WITH DESCRIPTIONS OF THE SPECIES.

Kingdom—**PLANTÆ.**

Section—**CRYPTOGAMIÆ.**

Class—**ACOTYLEDONES.**

Order—**CALAMARIÆ.**

Family—**EQUISETACEÆ.**

*Genus*—**CALAMITES**, Suckow, 1784.

(Act. Acad. Theodora-Palatina, v., p. 359.)

**CALAMITES VARIANS**, Germar.

*Calamites varians*, Germar, Verstein. Steinkohl. Wettin u. Lobejun., 1847, fas. 4, p. 47, t. 20

" " Sternberg, Flora, ii., p. 50, t. 12.

" " Ten. Woods, Journ. R. Soc. N. S. Wales for 1882 [1883], p. 188.

" " Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. i., p. 84.

*Obs.* The roots and stems are described by the Rev. J. E. Tenison Woods as of common occurrence at the undermentioned locality, but the leaves are rare. He says, "They abound in the strata, and there are some portions of the stone which seem to be made up entirely from the stems." These examples have not come under my notice.

*Loc. and Horizon.* Bogantungan, Drummond Range (*The late Rev. J. E. T. Woods*)—Star Beds.

**CALAMITES**, *sp. ind.*

*Obs.* The occurrence of so typical a Carboniferous plant as *Calamites*, amongst other genera, associated with a Carboniferous marine fauna in Eastern Australia, has, so far, been a point of considerable doubt and controversy. *Lepidodendron* has already been recorded,\* irrespective of the facts given in these pages. Of the two species known in Australia, one, *Calamites* (*Asterocalamites*) *scrobiculatus*, besides its Queensland habitat, occurs in the Lower Carboniferous of New South Wales, whilst *C. varians* is of doubtful horizon in the same country. In the specimen now about to be referred to, we have a plant from the Rockhampton Training Wall Quarries, which have yielded a rich Permo-Carboniferous fauna to the researches of Messrs. De Vis and the late James Smith, partaking of many of the characters of the genus *Calamites*.

The stems are long, narrow, parallel-sided, and not increasing in width, oval in section arising from compression, and producing a gently convex surface. The longest of the specimens is nine inches in length, with an average width of one and a-half inches, although one of the fragments is nearer two inches. The internodes are of irregular

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\* Ann. Report Dept. Mines N. S. Wales for 1889 [1890], p. 239.

length, the longest being about three inches and the shortest an inch and a-quarter. The nodes, although faintly marked, are sufficiently so to demonstrate the generic identity of the plant, and are very apparent on the application of the finger, but the pressure which the specimens have undergone renders them rather oblique. The costæ, or ribs, are fine, narrow, and close together, opposite on contiguous internodes, and not alternating. The fineness of the costæ probably indicates that the bark, when present, entirely concealed them, whilst the continuity of the costæ from internode to internode indicates *Archæocalamites* as the section to which the plant should be referred. There are no scars of branches along the nodes, as in either *Calamitina*, *Eucalamites*, or *Stylocalamites*.

The whole of the organic matter has been removed, the specimens being merely the infilling by matrix of the cavity left by the decomposition of the plant.

*Loc.* Lower Training Wall Quarries, Fitzroy River, Rockhampton (*The late James Smith*).

**Genus—*ASTEROCALAMITES*, Schimper, 1862.**

(Terr. Transition des Vosges, p. 321.)

***ASTEROCALAMITES SCROBICULATUS*, Schlotheim., sp., Pl. 4, figs. 11, 12.**

*Calamites scrobiculatus*, Schl., Petrefactenkunde, 1820, Abth. 1, p. 402, t. 20, f. 11.

„ *radiatus*, Brongniart, Hist. Foss. Vég., 1828, p. 122, t. 26, f. 2.

„ *radiatus*, Feistmantel, Palæontographica, 1879, Supp. Bd. iii., Lief. 3, Heft 4, p. 144, t. 6, f. 1, t. 7, ff. 3, 4.

„ *radiatus*, Ten. Woods, Journ. R. Soc. N. S. Wales for 1882 [1883], xvi., p. 187, t. 11, f. 5, t. 12, ff. 7, 10.

„ *radiatus*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, pp. 52, 83.

*Asterocalamites scrobiculatus*, Kidston, Cat. Foss. Plants, Brit. Mus., 1886, p. 35.

*Obs.* This species is quoted as a Queensland plant by the Rev. J. E. Tenison Woods at one part of his Paper on the “Fossil Flora of the Coal Deposits of Australia,” but is not described in that portion devoted to the specific diagnosis. My Colleague, however, quotes *Calamites radians*\* from a definite locality in Queensland, and this may perhaps be meant for the same species. Good examples have been collected by Mr. W. Fryar, Inspector of Mines, from Bogantungan, corresponding well with Mr. Woods’ figures. One of these exhibits five nodes and the other three.

*Loc. and Horizop.* Bogantungan, Drummond Range (*W. Fryar*) ; ? Drummond Range (*R. L. Jack*)—Star Beds.

**Family—SCHIZONEURIDÆ.**

**Genus—*PHYLLOTHECA*, Brongniart, 1828.**

(Prodrome Hist. Vég. Foss., p. 151.)

***PHYLLOTHECA AUSTRALIS*, Brongniart, Pl. 17, f. 13.**

*Phyllothea australis*, Brong., loc. cit., p. 152.

„ „ Morris in Strzelecki’s Phys. Descrip. N. S. Wales, &c., 1845, p. 250.

„ „ Dana, Geology Wilkes’ U. S. Explor. Exped., 1849, p. 718, t. 13, f. 6, t. 14, f. 1.

„ „ Feistmantel, Palæontographica, 1878, Supp. Bd. iii., Lief. 3, Heft 3, p. 83, t. 6, f. 3, t. 7, f. 1, 2, t. 15, f. 1 and 2 (?).

*Obs.* This plant is a very characteristic fossil of the Freshwater Beds of the Bowen River Coal Field Series. Some years ago I wrote on this point “that the

\* Handbook of Queensland Geology, 1886, p. 41.

remains are almost wholly those of plants, chiefly consisting of *Glossopteris* and *Phyllothea*." The Revd. J. E. T. Woods recorded *Phyllothea* (*P. indica*?) from the Oak Creek Coal Field and the Burrum River Coal Beds,\* but in a later publication he says,† "I now wish to state that, after a careful examination, there is no evidence that these specimens belong exclusively to *Phyllothea*." As, however, my Colleague regards the Oak Creek Coal Beds as the equivalents of the Freshwater Series at Bowen, it is not improbable that a *Phyllothea* does occur there in company with *Glossopteris*. A small specimen is figured (Pl. 17, fig. 13) and, although not very perfect, it corresponds with one of Dana's illustrations.‡ It was identified by Mr. R. Kidston.

*Phyllothea australis*, like *Glossopteris Browniana*, is one of the few plants which pass from the Palæozoic into the Mesozoic plant-bearing beds of Eastern Australia. Dr. Feistmantel has remarked on this fact in the following words: "This species has in Australia a distribution from the Lower Coal Measures . . . into the Upper Mesozoic Beds of Queensland and Victoria."

*Loc. and Horizon.* Cockatoo Creek, twelve miles up (*R. L. Jack*)—Upper or Freshwater Series of the Bowen River Coal Field.

## Order—FILICES.

### Family—SPHENOPTERIDÆ.‡

#### *Genus*—SPHENOPTERIS, Brongniart, 1822.

(Mem. Mus. Hist. Nat. Paris, viii., p. 233.)

#### SPHENOPTERIS LOBIFOLIA, Morris.

*Sphenopteris lobifolia*, Morris in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 246, t. 7, ff. 3, 3a.

" " Feistmantel, Palæontographica, 1878, Sup. Bd., iii., Lief. 3, Heft 3, p. 87.

" " Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1., p. 88.

*Obs.* This species is described as a very delicate fern, with very slender pinnules, varying much in shape according to position.

*Loc. and Horizons.* Near Cracow Creek, Dawson River (*The late R. Daintree*)—? Middle Series, Bowen River Coal Field; Rosella Creek, two miles above Havilah-Byerwin Road-crossing (*R. L. Jack*)—Marine Bed intercalated with the Upper or Freshwater Series, Bowen River Coal Field; Bowen River District (*Rev. J. E. T. Woods*; Colln. Woods)—Middle Series, Bowen River Coal Field?

#### SPHENOPTERIS FLEXUOSA, McCoy.

*Sphenopteris flexuosa*, McCoy, Ann. and Mag. Nat. Hist., 1847, xx., p. 150, t. 9, ff. 4, 4a.

" " Feistmantel, Palæontographica, 1878, Sup. Bd. iii., Lief. 3, Heft 3, p. 88.

" " Tenison Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 91.

*Obs.* A very graceful fern has occurred, thickly covering altered shale from the Dawson River, and associated with *Glossopteris*. It possesses the elongately lobed pinnules of this species, the characteristic forked venation, and the terminal trilobed division.

\* Proc. Linn. Soc. N. S. Wales, vol. viii., p. 95.

† Fossil Flora of the Coal Deposits of Australia. Sydney, 1883, p. 38.

‡ Dana, loc. cit., t. 13, f. 6.

§ In addition to this family we believe we have the Pecopteridæ represented in specimens from Walker's Creek, near Nebo, and Dinner Creek, Stanwell. In each case the Pecopterid plant is accompanied by *Glossopteris Browniana*, Brong.

The Rev. J. E. Tenison Woods does not quote this species as a Queensland fern, but in its place records the above species *S. lobifolia* from near Cracow Creek, Dawson River. This is, of course, quite possible; but after a very careful examination of the present specimens, assisted by Mr. T. Whitelegge, my Colleague in the Australian Museum, I can come to no other conclusion than that *S. flexuosa* must also be added to the list.

*Loc. and Horizon.* Dawson River (*H. Mackay*; Colln. De Vis)—Upper or Freshwater Group of the Bowen River Coal Field.

#### SPHENOPTERIS CREBRA, *Ten. Woods?*

*Sphenopteris crebra*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 93, t. 3, f. 4.

*Sp. Char.* Frond evidently tender and membranaceous, bipinnate; pinnæ wide, alternate, slightly oblique, oblong-quadrate, pinnules so close together as not to be easily distinguished, faintly pinnatifid; lobes a little more oblique than the pinnæ, oblong-ovate, with a slightly undulating margin; costæ sending off veins which fork once, and the venules reaching the margin. (*Ten. Woods.*)

*Obs.* Specimens before me are not sufficiently perfect to show the pinnæ, but, so far as one can judge from the brief characters of the pinnules, and the indistinct figure, they are the above species. The pinnules are quite close together, almost overlapping in places, but this may be due, perhaps, to some extent to pressure; oblong-ovate in outline, and with practically an entire margin. The veins fork only once, and all the venules reach the margin; of the former there are three on each side the midrib to the pinnule.

Our specimens are distinguished from *Sphenopteris exilis*, Morris, *S. lobifolia*, Morris, *S. germanus*, McCoy, *S. flexuosa*, McCoy, and *S. plumosa*, by the almost entire margins of the pinnules; from *S. hastata*, McCoy, by the differently formed pinnule, the latter in the present examples varying from oval-pyriform to oblong-ovate. Mr. Woods speaks of the lobes of the pinnules, but if these are to any extent developed in the Ballimore Coal Field examples, our Queensland fossils must then be considered distinct, for the pinnules in the latter would certainly not come under this category.

*Loc. and Horizon.* Dawson River (*H. Mackay*; Colln. De Vis)—Upper or Freshwater Group of the Bowen River Coal Field.

#### Family—PALÆOPTERIDEA.

#### Genus—*ANEIMITES*, Dawson, 1860.

(Quart. Journ. Geol. Soc., xvii., p. 5.)

#### *ANEIMITES AUSTRINA*, *Etheridge fil.*

*Aneimites austrina*, Etheridge fil., Proc. Linn. Soc. N.S.W., 1888, iii., Pt. 3, p. 1304, t. 37.

*Sp. Char.* Frond elongately expanding, bipinnate; rachis moderately broad, carinate; pinnæ sub-alternate, elongate, attenuating but slowly towards their apices, almost parallel-sided; rachis carinate, frequently zigzag; pinnules petiolate, rather inequilateral, varying in shape on different parts of the frond, but generally ovate or obovate-pyriform, sometimes a little sub-imbricate, proximal or inner margins parallel to the rachis, upper and distal margins broadly rounded, and all entire; pinnules towards the apices of the pinnæ becoming more truly pyriform or pyriform-deltoid, the terminal leaflets being uni-, bi-, or tri-lobed; pinnules of the lowest (preserved) pinnæ lobate, the apical lobe more or less lanceolate. Petioles short and straight. Nerves well marked, numerous, bi- or perhaps tri-dichotomous.

*Obs.* The relation of this plant is with the group of ferns represented by such genera as *Cyclopteris*, *Archæopteris* (= *Palæopteris*), *Rhacopteris*, *Adiantites* (so-called), and others. The resemblance is specially strong to *Cyclopteris* and *Adiantites*, but I believe Professor Göppert, the author of the latter, abandoned his genus in favour of *Cyclopteris*.

In originally proposing *Aneimites*,\* Principal Dawson evidently had in mind the British Coal Measures fern, *Sphenopteris adiantoides*, Lindley and Hutton; so much so that to this he at first referred the plant afterwards called by him *Aneimites* (*Cyclopteris*) *acadica*.†

This being the case, we may justly include *Sphenopteris adiantoides* in *Aneimites*. Furthermore, it is to be regretted that Principal Dawson did not refer to this obvious fact in his second and more detailed account of the Canadian fern.

The strong resemblance borne by the Queensland specimen to the British *Aneimites adiantoides*, L. and H., sp., and in a less degree to *A. acadica*, Dn., renders it exceedingly probable that it should be placed in the genus in question. I shall, therefore, speak of it in future as *Aneimites austrina*.

The pinnæ of *A. austrina* are about three inches long, the entire frond, as preserved, occupying a space of more than one foot. The frond is generally flabellate and bipinnate, there being portions of eight pinnæ on one side, alternating with seven on the other, of a rather broad rachis. The pinnæ are elongate and generally narrow, hardly expanding from a uniform width, and decreasing but very slowly in width towards their apices. The pinnules are ovate or obovate-pyriform, and retain their form throughout the length of each pinna until near their apices, when the pinnules become longer and more wedge-shaped, the pinna terminating in a uni-, bi-, or tri-lobed pinnule. The pinnules have likewise a somewhat flabellate aspect, seldom sub-imbricate, or overlapping one another, but separated by an interspace, which is certainly at times rather inconspicuous. The proximal margins of the pinnules are parallel to the rachis, and during fossilisation some of them have slightly infringed on the latter.

The two lowest pinnæ exhibit a marked difference from those above them. The second pair are the best preserved and are deeply lobate and pinnatifid, conforming to the habit we are accustomed to associate with the pinnules in some *Sphenopterids*. The divisions of the pinnæ in question have quite lost their pyriform or obovate outline, but are irregularly trilobate, and to some extent incised, the apical lobe being the largest, and more or less lanceolate. The nerves are but faintly visible on the specimen occupying the greater portion of the slab, but are shown on a smaller example lying near. The lower pinnæ seem to be only a modification of the lobate apical pinnules of the higher pinnæ, as seen on the third to the right from the bottom of the specimen, and the fifth and sixth on the left hand. But they are not the basal, as the lower portion of the frond is concealed by matrix.

The resemblance of *A. austrina* to *A. adiantoides* consists in the similar obovate or pyriform pinnules, with a like modification of the apical pinnules. The two ferns, however, differ greatly in the relative sizes of their respective portions, whilst in the British species there is no appearance of the dissimilar lower pinnæ.

From *A. acadica*, Dn., the form of the pinnules will at once distinguish it.

*Loc. and Horizon.* Near Mount Budge, Drummond Range (*A. E. Holmes*; Colln. Smith)—Star Beds.

\* Quart. Journ. Geol. Soc., 1860, xvii., p. 5.

† The Fossil Plants of the Lower Carboniferous and Millstone Grit Formations of Canada. Geol. Surv., Canada, 1873, p. 26.

## Family—DICTYOTÆNIOPTERIDÆ.

Genus—*GLOSSOPTERIS*, Brongniart, 1828.

(Prodrome Hist. Vég. Foss., p. 54.)

*Obs.* Besides the Permo-Carboniferous localities in which different species of this genus afterwards referred to have been discovered, the genus also occurs in the Desert Sandstone.

That the plants discovered at Cement Hill, near Clermont,\* are *Glossopteris* there can be no reasonable doubt, but I must be allowed to consider my Colleague and his Assistant, Mr. W. H. Rands, as wholly responsible for the reference of the beds from which the specimens come, to the upper member of the Queensland Cretaceous, the Desert Sandstone.† The case is, however, a parallel one to the supposed occurrence of *Glossopteris* in the Cretaceous of Russia, or the Tertiary rocks of Italy;‡ but in these cases there is an element of doubt whether or no the leaves in question are truly those of *Glossopteris*.

The Clermont plants came to hand too late for description in these pages, but they will appear amongst supplementary descriptions of Queensland fossils.

*GLOSSOPTERIS BROWNIANA.*

Brongniart, Pl. 16, figs. 6 and 8; Pl. 17, figs. 9 and 10.

*Glossopteris Browniana*, Brong., Hist. Vég. Foss., 1828, p. 223, t. 62.

" " Morris in Strzelecki's Phys. Descrip. N. S. Wales, 1845, p. 247, t. 6, f. 1 and 1a.

" " Dana, Geology Wilkes' U. S. Explor. Exped., 1849, p. 716, Atlas, t. 12, f. 13.

" " Feistmantel, Palaeontographica, 1878, Sup. Bd. iii., Lief. 3; Heft 2, p. 78; Heft 3, p. 90, t. 8, f. 3 and 4, t. 19, f. 1, 1a, 3, 4, and 4a, 5 and 5a, 7, t. 11, f. 1.

*Obs.* This much abused and disputed plant is very characteristic, in Queensland, of the equivalents of the Upper Coal Measures of New South Wales. It is, undoubtedly, associated with the coal-seams of the Cooktown area, and on the specimens submitted to him from this locality Mr. Robert Kidston makes the following remarks:—"Among the specimens are some which may perhaps be referred to the variety *australasica* of Brongniart. Schimper mentions in his *Traité de Pal. Vég.* (vol. i., p. 646) that the form of the fronds varies much according to their age, and that he had seen on the same slab some that were almost linear, and others that were oblong-spathulate."

*G. Browniana* occurs in the Upper or Freshwater Series of the Bowen River Coal Field, which, like the Middle or Marine beds, possesses a Palæozoic fauna, but in a less degree. On the subject of the Marine bands in the former, I formerly made the following remarks:—

"The Marine bed at Rosella Creek contains *Goniatites micromphalus* (Morris) and some indeterminable fragments of other Mollusca. The similar bed at the Havilah-Byerwin Road contains magnificent specimens of a particularly characteristic Carboniferous Brachiopod *Derbyia senilis*, Phillips, in company with *Productus brachythærus*, G. Sowerby, and a bivalve, either a *Pachydomus* or *Astartila*.

Striking confirmation is again afforded by yet another locality, Cockatoo Creek, where we have *Glossopteris* and *Phyllothea* actually in company with *Strophalosia Clarkei*, Eth."

\* See p. 169.

† What I said (see p. 170) was that beds in which *Glossopteris* occurs, unaccompanied by other fossils, "may be of any age from the Lower" [I should have said "Middle"] "Bowen to the Desert Sandstone." (R.L.J.)

‡ Feistmantel, Geol. Pal. Relations Coal and Plant-bearing Beds of E. Australia. *Mem. Geol. Survey N. S. Wales, Pal. No. 5*, 1890, p. 119.

My Colleague's testimony on this subject is of the highest value. He says in connection with a Bore (No. 1) put down on Pelican Creek through the Middle or Marine Series—"The most interesting feature of this bore, is the presence, at the base of the Marine Series, of a considerable thickness of strata, containing *Glossopteris*, and undoubtedly on a lower horizon than the sandstone overlying the Garrick seam, which contain marine fossils."\* This would appear to entirely corroborate the previously expressed opinion of the late Mr. Daintree on the occurrence of *Glossopteris* in the Bowen Marine Series.†

In our illustrations we have given more than one variety of this fern. In Pl. 16, figs. 6 and 8, are two very finely reticulated leaves resembling a figure by Feistmantel‡ and another by Morris.§ In Pl. 17, fig. 9, is a somewhat coarser form, but fig. 10 of the same plate seems to represent the true variety intended by Brongniart, under the name of *australasica*|| with a coarser and more open reticulation.

*Loc. and Horizon.* MacArthur Creek, below MacArthur Coal-Seam; Cockatoo Creek, three and a-quarter, eleven, and twelve miles up, Bowen River Coal Field (*R. L. Jack*); Walker's Creek, near Nebo (*R. L. Jack*); Stewart's Creek, near Townsville (*R. L. Jack*); Dinner Creek, Stanwell (*The late James Smith*); Dawson River (*H. Mackay*; Colln. De Vis)—Upper or Freshwater Series (Upper Coal Measures of New South Wales).

*G. Browniana* has been recognised by Mr. Robt. Kidston in later Collections of Mr. Jack's from Dave Creek, Little River, Cooktown; from a parting in a coal-seam at the Little River, Cooktown; from impure coal, south of the "forty-five acre seam;" from "Built-up sidling" on old road from Daddy's to Deep Creek, Cooktown. Mr. Kidston has also determined a *Glossopteris* from the right bank of the Little River, half-a-mile below Fairlight Station, Cooktown, and also from Baird's Mine, Oakey Creek, on which he remarks—"The specimens are too imperfect for specific determination, but probably most of them are referable to *Glossopteris Browniana*."

#### GLOSSOPTERIS LINEARIS, McCoy, Pl. 18, fig. 14.

*Glossopteris linearis*, McCoy, Ann. and Mag. Nat. Hist., 1847, xx., p. 151, t. 9, f. 5 and 5a.

„ Feistmantel, Palaeontographica, 1878, Supp. Bd. iii., Lief. 3, Heft 3, p. 91, t. 8, f. 1 and 2, t. 11, f. 3 and 4, t. 12, f. 4.

*Obs.* This species has been identified by Mr. Kidston amongst my Colleague's gatherings from the Oakey Creek Coal Field. In New South Wales it occurs in the Newcastle Coal Field, at Woollongong, and other places. In the Bowen River District, *G. linearis* is found associated with *Phyllothea* and *Strophalosia Clarkei*, and is further confirmatory evidence of the occurrence of this interesting genus in company with Palaeozoic Mollusca. In Pl. 16, fig. 4, the neuriation would appear to spring from the midrib at too near a right angle to fully correspond with the recognised figures of this species.

*Loc. and Horizon.* Cockatoo Creek, Bowen River Coal Field (*R. L. Jack*); Baird's Mine, Oakey Creek Coal Field, Cooktown (*R. L. Jack*)—Upper or Freshwater Series of the Bowen River Coal Field.

\* Handbook Geol. Queensland, 1886, p. 44.

† Quart. Journ. Geol. Soc., 1872, xxviii., p. 286.

‡ Palaeontographica, loc. cit., t. 10, f. 5.

§ Strzelecki, loc. cit., t. 6, f. 1.

|| Brongniart, loc. cit., t. 62, f. 1.



## GLOSSOPTERIS AMPLA, Dana, Pl. 15, fig. 7.

*Glossopteris ampla*, Dana, Geology Wilkes' U. S. Explor. Exped., 1849, p. 717; Atlas, t. 13, f. 1.

„ Feistmantel, Palaeontographica, 1878, Supp. Bd. iii., Lief. 3, Heft 3, p. 91, t. 11, f. 2, t. 12, f. 7.

*Obs.* The discovery of this fern in Northern Queensland, associated with a Palæozoic fauna, may be regarded as one of the most important palæontological facts brought to light by my Colleague's surveys. It entirely corroborates the often-repeated statements of the late Revd. W. B. Clarke and Mr. W. Keene that *Glossopteris*, whatever its stratigraphical position might be in other countries, was associated with Palæozoic Marine beds in New South Wales. I cannot do better than quote here the remarks I originally made when first recording the appearance of this fern in company with Palæozoic shells in the Upper or Freshwater Series of the Bowen River Coal Field:—

“In the case of the Coral Creek deposit, we have an assemblage of fossils most carefully collected, and all presenting traces of one and the same matrix. An undoubted *Glossopteris* occurs here, near *G. ampla*, Dana, in company with Polyzoa of an Upper Palæozoic type, such as *Fenestella*, *Protoretepora*, two species of *Stenopora*, a specimen which is either *Productus* or *Strophalosia*, probably the latter; bivalves of the genera *Pachydomus* and *Mæonia*, another which I cannot distinguish from *Aviculopecten limæformis*, Morris, and certainly *Pterinea macroptera*, Morris. An assemblage of fossils such as this would have been considered by all those who have in previous years written on the subject, Professors Morris, McCoy, Dana, and Jukes, Mr. Daintree and others, as representing the Upper Palæozoic Series of New South Wales, &c.

“In a Presidential Address delivered to the Royal Society of Victoria on the 25th April, 1864,\* Professor McCoy tells us that in a discussion which took place at the reading of a Paper by Mr. Daintree, the latter mentioned ‘a fact of the highest importance, and which may be found in some measure to reconcile the view of Mr. Clarke and myself, namely, that Mr. Clarke in making his original collections for determination had mixed together the fossils of the upper and the lower beds. Now, as a portion of the fossils could be identified with European species, and there were among them two species of Trilobites (*Phillipsia* and *Brachymetopus*), characteristic of the Mountain Limestone as found in Ireland and Russia, the clearly marked age of these would have determined the age of the whole, if, as was supposed, they came from the same beds; and in this indirect way the *Pachydomi* and other new generic and specific forms which, from their novelty, could not afford any indication of age of themselves, came to be considered as Palæozoic forms from their supposed associations with those which certainly were of that age. It is obviously, therefore, necessary to collect and investigate the evidence afresh from each bed by itself with care,’ &c. These remarks, although undoubtedly sound in principle, will not apply in this case, for we have here careful collecting, showing that *Glossopteris* does actually exist in a deposit with a marine fauna, amongst which is at least one specimen of *Productus* or *Strophalosia*. Further, the same species of Polyzoa which are found in abundance in the Coral Creek deposit with the *Glossopteris* are also met with at Pelican Creek, where the characteristic fossil is *Strophalosia Clarkei*.

“Taking all these facts into careful and unbiassed consideration, it appears to me impossible to doubt, if the Coral Creek fauna is admitted to be of Permian-Carboniferous age, or, at any rate, of Upper Palæozoic, that we now have a tangible demonstration of the occurrence of *Glossopteris* in actual company with such a fauna.”

*Loc. and Horizon.* Coral Creek, Bowen River Coal Field (*R. L. Jack*)—Middle or Marine Series.

\* Trans. R. Soc. Vic., 1865, vi., p. lxvi.

## Order—LYCOPODIACEÆ.

## Family—LEPIDODENDRIDÆ.

Genus—*LEPIDODENDRON*, Sternberg, 1820.

(Flora der Vorwelt, i., Fasc. i., p. 25, Fasc. 4, p. x.)

*LEPIDODENDRON AUSTRALE*, McCoy, Pl. 5, figs. 1-10.

- Lepidodendron* (*Bergeria*) *australe*, McCoy, Prod. Pal. Vict., Dec. i., 1874, p. 37, t. 9.  
 „ *nothum* (*pars.*), Carruthers (*non* Unger), Quart. Journ. Geol. Soc., 1872, xxviii., Pt. 3, p. 353, t. 26, f. 11-14 (excl. figs. 1-4, 6-9).  
 „ *nothum*, Feistmantel, Palaeontographica, 1878, Supp. Bd. iii., Lief. 3, Heft 2, p. 69, t. 1, f. 1-5; *Ibid.*, 1879, Heft 4, p. 141, t. 1 (19), f. 1 and 2.  
 „ *australe* et *L. nothum*, Ten. Woods, Proc. Linn. Soc. N. S. Wales for 1883 [1884], viii., Pt. 1, pp. 134 and 135.

*Obs.* Both Mr. Robert Kidston and the Writer are quite in accord with Prof. McCoy in considering the plant described by Mr. Carruthers under the name of *Lepidodendron nothum*, Unger, as identical with *L. australe*, McCoy.\* Mr. Kidston remarks in his notes on the Queensland plants:—"The type of *Lepidodendron nothum*, Unger,† on account of its imperfect preservation does not appear to afford any specific character from external markings, by which other specimens can be satisfactorily identified with it; therefore the identification of the Queensland or Tasmanian specimens with Unger's plant does not appear admissible." Prof. McCoy remarks that "The scars are so much larger and fewer on approximately the same sized branches" (*i.e.*, of *L. australe*), "that it is not desirable to make such a reference" (*i.e.*, to *L. nothum*, Unger). *Lepidodendron nothum*, Carruthers (*non* Unger), is believed by Mr. Kidston to include two species, belonging in part to *L. australe*, McCoy, and in part to *Leptophlæum rhombicum*, Dawson.‡ According to this view, Mr. Carruthers' figures (Pl. 26, *loc. cit.*, figs. 11-14), must be referred to *L. australe*, and the remainder given on his plate (figs. 1-4, 6-9) to *Leptophlæum rhombicum*. The differences in the form of the leaf-scar, the position of the vascular cicatricule, and mode of growth of these specimens, seems to prohibit their being included in one species." The latter figures have a great resemblance to *Leptophlæum rhombicum* in the form of the scar and position of the cicatricule.

*Loc. and Horizon.* Corner, Sandy, Horse, and Donald's Creeks, Great Star River (*R. L. Jack* and *P. W. Pears*); Road to Harvest Home, two miles west of Mount McConnell (*P. W. Pears*); Mount Wyatt, Canoona, Broken River (*The late R. Daintree*); Medway River, Bogantungan, and Drummond Range (*The late Rev. J. E. T. Woods*)—Star Beds; Training Wall Quarries, Rockhampton, with marine mollusca (*The late James Smith*); Murphy's Tunnel, Pioneer Hill, Hodgkinson Gold Field (*R. L. Jack*)—Gympie Beds.

*LEPIDODENDRON VELTHEIMIANUM*, Sternberg, Pl. 4, fig. 8, Pl. 6, fig. 2.

- Lepidodendron veltheimianum*, Sternberg, Flora der Vorwelt, 1870, i., Fasc. 4, p. xii., t. 52, f. 3.  
 „ „ Feistmantel, Palaeontographica, 1879, Bd. iii., Lief. 3, Heft 4, p. 151, t. 7, f. 2 (? t. 5, ff. 2 and 3).  
 „ „ Ten. Woods, Journ. R. Soc. N. S. Wales for 1882 [1883], xvi., p. 182, t. 11, f. 1, 3, and 6, t. 12, f. 8.  
 „ „ Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 135.

*Obs.* This Lycopod was recorded as a Queensland species by the late Rev. J. E. Tenison Woods. It occurs as compressed branches, with impressions of distant narrow-pointed leaf-like scales.

\* For a full discussion of the relation of these two plants see my Paper—*Lepidodendron australe*, McCoy: Its Synonyms and Range in Eastern Australia. *Records Geol. Survey N. S. Wales*, 1891, ii., Pt. 3, pp. 119-134. (*R. E., junr.*)

† Denkschr. Akad. Wiss. Wien, xi., 1856, p. 175, Pl. x., f. 4-8.

‡ Geol. Surv., Canada. Foss. Plants, Dev. and Up. Silurian Form. Canada, 1871, p. 36, t. 8, figs. 88 and 89.

Two good examples are included in my Colleague's Collection, showing the elongated, narrow, and long diamond-shaped scars characteristic of the species. These are accompanied by examples of the *Knorr* condition (Pl. 6, f. 2).

*Loc. and Horizon.* Drummond Range (*R. Sexton and the late Rev. J. E. Tenison Woods*); Bogantungan, Drummond Range (*W. Fryar*)—Star Beds.

LEPIDODENDRON, *sp. ind.*, Pl. 6, figs. 1 and 4.

*Obs.* A third, and perhaps even a fourth, species of *Lepidodendron* is represented by the above figures. In both cases the scars have been rendered too plainly by the Artist. For want of sufficient material I have not attempted to determine them.

*Loc. and Horizon.* Bogantungan, Drummond Range (*W. Fryar*); Corner Creek, Great Star River (*P. W. Pears*)—Star Beds.

Genus—CYCLOSTIGMA, *Haughton*, 1860.

(Ann. and Mag. Nat. Hist., 1860, v., p. 443.)

CYCLOSTIGMA AUSTRALE, *Feistmantel*.

*Cyclostigma australe*, Feist., Palaeontographica, 1878, Supp. Bd. iii., Lief. 3, Heft 2, p. 76, t. 4, f. 3, t. 5, f. 1.

„ *sp.*, Ten. Woods, Journ. R. Soc. N. S. Wales for 1882 [1883], xvi., p. 184.

„ *australe*, Ten. Woods, Proc. Linn. Soc. *ibid.*, 1883, viii., Pt. 1, pp. 52 and 138.

*Obs.* The late Rev. J. E. T. Woods obtained a specimen from the Drummond Range which he thought might be this species.

*Loc. and Horizon.* Drummond Range (*The late Rev. J. E. T. Woods*)—Star Beds.

CYCLOSTIGMA, *sp. ind.*

*Cyclostigma, sp.*, Feistmantel, Palaeontographica, 1878, Supp. Bd. iii., Lief. 3, Heft 2, p. 71.

„ „ Journ. R. Soc. N. S. Wales for 1880 [1881], xiv., p. 116.

*Obs.* A plant very closely allied to *Cyclostigma killtorkense* is said by Dr. Feistmantel to occur in Queensland in company with *Lepidodendron nothum* (*L. australe*, McCoy), but it may possibly be the last species only.

*Loc. and Horizon.* Mount Wyatt and Canoona (*Dr. O. Feistmantel*)—Star Beds.

Genus—STIGMARIA, *Brongniart*, 1822.

(Mém. Mus. Nat. Hist. Paris, viii., p. 209.)

STIGMARIA, *sp. ind.*

*Stigmara*, Ten. Woods, Journ. R. Soc. N. S. Wales for 1882 [1883], p. 192, t. 12, f. 8.

*Obs.* The late Rev. Mr. Woods did not describe this specimen, but remarked simply—“This fragment lay in the position of a root in the rock, subtending a stem probably of *Lepidodendron veltheimianum*.”

*Loc. and Horizon.* Bogantungan, Drummond Range (*The late Rev. J. E. T. Woods*)—Star Beds.

## Section—PHANEROGAMIA.

## Class—DICOTYLEDONES.

## Order—CYCADACEÆ.

## Family—CORDAITEÆ.\*

Genus—*CORDAITES*, Unger, 1850.

(Gen. et Sp. Plantarum, p. 277.)

*CORDAITES AUSTRALIS*, McCoy.*Cordaite australis*, McCoy, Prod. Pal. Vict., Dec. iv., 1876, p. 22, t. 36, f. 6, 7.

,, ,, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 155

*Obs.* The leaves of *C. australis* have been recorded by the Rev. J. E. Tenison Woods from the plant beds of the Drummond Range (Star Beds). He says—"I believe I have identified the same species in the shales and slates of Gympie, Queensland (Lady Mary Shaft), and also in the sandstone ranges at the Drummond Range (Bogantungan), in the sandstone about one mile west of the railway station. In both it is not very abundant." The plant has not occurred in any Collection I have examined from either of the above localities.

## Order—CONIFERÆ.

## Family—ARAUCARIÆ.

Genus—*ARAUCAROXYLON* (Krauss), Schimper, 1870.

(Traité Pal. Vég., 1870, ii., Pt. 1, p. 380.)

*ARAUCAROXYLON NICHOLI*, Carruthers (MS.)*Araucaroxylon Nicholi*, Carruthers in Etheridge, fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 328.

*Obs.* This name was given by Mr. W. Carruthers, F.R.S., to some wood obtained by Mr. Jack in the Bowen River Coal Field. As Mr. Carruthers has since failed to describe it, the name had better lapse, and be erased from nomenclature. It would not have been referred to here had it not been necessary to account for the name, which has unfortunately crept into literature.

The occurrence of Coniferous wood, however, is in itself an interesting fact, as affording still further evidence of the identity of the Bowen Coal Measures with the corresponding series in New South Wales. My Colleague states that in the Middle or Marine Bowen beds "portions of the trunks of coniferous trees are occasionally found lying horizontally in the strata."† Again, in the Upper or Freshwater Series of the same area, the strata exposed in Jack's Creek contain "numerous large drifted trees (Coniferous). These occasionally retain some part of the branching roots. They are silicified to a black flint, sometimes partly opalised."‡ In another place he adds—"One tree was found to measure thirty-one feet in length."§ And what is of equal importance, "the same species of drifted coniferous wood is common to the Marine and Freshwater Series."||

\* Lesquereux, Coal Flora Carb. Form. Pennsylvania, 1880, p. 527. "The Cordaiteæ are now generally referred to the Dicotyledonous Gymnosperms, as intermediate in character between the Cycadaceæ and the Conifers." (Lesquereux.)

† Report on the Bowen River Coal Field. Brisbane: by Authority: 1879, p. 7.

‡ *Ibid.*, p. 22.

§ Handbook Geol. Queensland, 1886, p. 45

|| Report, *loc. cit.* p. 35.

## Kingdom—ANIMALIA.

## Sub-Kingdom—PROTOZOA.

## Class—SPONGIDA.

## Order—MONACTINELLIDÆ.

## Family—

Genus—*LASIOCLADIA*, Hinde, 1883.

(Cat. Foss. Sponges Brit. Mus., p. 19.)

*LASIOCLADIA*? HINDEI, *sp. nov.*, Pl. 41, figs. 1 and 2.

*Sp. Char.* Form, as preserved, fan-shaped, originally globular or rotund probably, measuring one and three-quarters by one and a-quarter inches, formed of long, radiating, rod-like, siliceous spicules, closely compressed or matted together, and apparently all placed in one outward direction. Spicules very equal in size.

*Obs.* The general appearance of this organism is that of a semi-circular or fan-shaped body, split in half longitudinally on the weathered surface of an indurated non-calcareous shale. To the naked eye the surface simply appears roughened, but when magnified, rod-like spicules and their impressions are at once apparent. Their direction is very regular, having a definite radiate arrangement, but there does not appear to be any attempt at transverse or obliquely placed spicules. On the bottom of the specimen, where ground down, the spicules are visible in sections, which are circular and solid. All the rods seem to be simple, and are undoubtedly siliceous.

This interesting form is provisionally referred to *Lasiocladia*, Hinde, but the spicules are not loosely arranged in more than one direction, as in that genus. The remark of Dr. Hinde that "the larger portion of the specimen merely shows the empty well-defined moulds of the spicules in the shale," quite applies here. These rods do not seem to be in any way allied to the long rope-like anchoring spicules of *Hyalostelia*, in that they are solid, and not wholly parallel with one another.

Drawings of this sponge were submitted to Dr. J. G. Hinde, who replied—"It is very probable that the specimen of which you enclose drawings is a Monactinellid sponge, but further than that I can form no opinion." Notwithstanding my friend's cautious reply, I have ventured to provisionally refer this sponge to *Lasiocladia*, uniting with it his name. The rarity of sponges in our Australian Permo-Carboniferous rocks demands that every possible attention should be called to their occurrence, and no better plan can be adopted than that of giving the fossil a name. I have not been able to isolate any of the spicules, and am, therefore, debarred from giving measurements.

*Loc. and Horizon.* Rockhampton District\* (*C. W. De Vis*; Colln. *De Vis*)—Gympie Beds.

\* The fossils of the Collection received from Mr. De Vis do not bear separate localities, but are all from the Rockhampton District. In a letter dated 25th July, 1888, Mr. De Vis says—"The fossils are from the Agricultural Reserve; from the Fitzroy at Laurel Bank, about ten miles from Rockhampton, westward to the Nine-mile Lagoon; thence to the Corporation Quarry, Athelstane Range, and to the northern outcrop (at foot of Bersekers) of the synclinal beneath the township and bed of river."

## Sub-Kingdom—CŒLEENTERATA.

## Class—ACTINOZOA.

The Actinozoa are but very sparingly represented in the Permo-Carboniferous of Queensland and New South Wales,\* and, so far as known to me, the same remark is applicable to Tasmania also. This applies, not only to individual genera and species, but also to the orders of the class. The Zoantharia are perhaps represented by the genus *Stenopora*, whilst the Rugosa in the present collection number but a few ill-preserved and undeterminable fragments. If this paucity of the Coral fauna should be found to hold good in the future, as more extended researches are carried out, it will, in conjunction with the repeated occurrence of *Stenopora*, greatly assist in supporting the view here advocated of the marked Permian *facies* of portions of the Upper Palæozoic fauna of New South Wales and Queensland.

## Order—RUGOSA.

## Group—ZAPHRENTOIDEA.

## Family—ZAPHRENTIDÆ.

*Genus—ZAPHRENTIS, Rafinesque and Clifford, 1820.*

(Ann. Sci. Phys. Bruxelles, v., p. 234.)

*ZAPHRENTIS PROFUNDA, sp. nov., Pl. 44, fig. 1.*

*Sp. Char.* Corallum long and probably much curved, calice very deep, curved and wide, rather more oval than circular; floor formed by a very irregular and limited tabulum; a crest or callus is present on the dorsal side, and is formed by a convergence of the septa. The latter are very numerous, at least forty-six primary and a similar number of secondary, and pass well on to the floor; secondary septa rather more than one-third the length of the primaries; septal fossula deep, immediately under the ventral wall, bounded by two primary septa, and undivided by the intrusion of the counter septum. Dissepiments very numerous, forming a close and dense tissue. Depth of the calice eleven lines on the dorsal side, but one and a-half inch on the ventral; longest diameter one and a-quarter inch, from the dorsal to the ventral side.

*Obs.* This is a very remarkable species, and appears to be quite distinct from any hitherto described Australian form. The large number of septa and the narrow oblique calice-floor are important and definite characters. The difference between the curvature of the dorsal and ventral sides is very great. The crest is situated at the top of the elongated fossula, with the dorsal and ventral septa converging thereto, the latter passing along the margins of the fossula; a second crest occurs at the immediate entrance to the latter, which does not seem to be otherwise divided.

*Loc. and Horizon.* Rockhampton District † (*C. W. De Vis*)—Gympie Beds.

\* For a full description of all the species known from N. S. Wales, see my Memoir: A Monograph of the Carboniferous and Permo-Carboniferous Invertebrata of New South Wales. Part I.—Cœlenterata. Mem. Geol. Survey N. S. Wales, Pal. No. 5. 4to. Sydney, 1891: by Authority.

† See note, p. 199.

## Group—CYATHOPHYLLOIDEA.

## Family—CYATHOPHYLLIDÆ.

## Genus—CYATHOPHYLLUM, Goldfuss, 1826.

(Petrefacta Germaniæ, I. Theil, p. 54.)

CYATHOPHYLLUM, *sp. ind.*, Pl. 3, fig. 10.(Compare *C. helianthoides* (Goldf.), Edwards and Haime, Mon. Brit. Foss Corals, Pt. 4, Dev., 1853, p. 227, t. 51, f. 1.)

*Obs.* A large single corallum after the type of *C. helianthoides* has been found at the Hodgkinson Gold Field, but too imperfect for full description. The diameter across the calice was at least three inches, and in all probability much more. The septa were very numerous, and a large quantity of dissepimental tissue also existed. The former are too stout and not sufficiently numerous for the Carboniferous type, *Cyathophyllum Stutchburyi*,\* but are formed much more on the lines of the Devonian *C. helianthoides*,† and the dissepimental tissue filling the interseptal loculi also closely resembles that of this species.

*Loc. and Horizon.* Beaconsfield, Hodgkinson Gold Field (*R. L. Jack*)—Gympie Beds?

CYATHOPHYLLUM, *sp. ind.*, Pl. 7, fig. 1.

*Obs.* A portion of what must have been a gigantic coral, having a diameter of at least seven and a-half to eight inches, is represented in Pl. 7, fig. 1. The figure displays a natural section taken horizontally from the radial centre outwards to the circumference or thereabouts. It is much altered by mineralization, but the septa, of which there are an enormous number, are distinctly visible, and so are the dissepiments. In the portion preserved, which represents only about one-tenth of the entire corallum, there are forty septa, or more. This is probably one of the largest Cyathophylloids known, and it is to be regretted that more ample material is not forthcoming to enable a full description to be given. It clearly belongs to the group of *Cyathophyllum Stutchburyi*, judging from the large number of septa, and the close-set dissepiments.

*Loc. and Horizon.* Limestone, near Langmorn, Port Curtis (*W. H. Rands*)—Gympie Beds?

## Section—PERFORATA.

## Family—AULOPORIDÆ.

## Genus—CLADOCHONUS, McCoy.

(Ann. and Mag. Nat. Hist, 1847, xx., p. 227.)

## CLADOCHONUS TENUICOLLIS, McCoy.

*Cladochonus tenuicollis*, McCoy, loc. cit. p. 227, t. 11, f. 8.

,, ,, Etheridge fil., Cat. Australian Foss., 1878, p. 34 (for general synonymy).

*Obs.* A single corallite, in Mr. De Vis' Collection, shows the presence of this coral in the Queensland Permo-Carboniferous rocks. It is on a weathered surface, but does not afford any additional information to that already known.

*Loc. and Horizon.* Rockhampton District (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

\* Edwards and Haime, Mon. Brit. Foss. Corals, Pt. 3, Carbonif., 1852, p. 179, t. 31, ff. 1 and 1a.

† Edwards and Haime, *Op. cit. supra*.

## Order—MONTICULIPORIDEA.

## Family—MONTICULIPORIDÆ.

## Genus—MONTICULIPOREA, D'Orbigny, 1849.

(Prodrome Pal., i., p. 25; Emend. Nicholson, Tab. Corals Pal. Period, 1879, p. 269.)

MONTICULIPOREA, *sp. ind.*, Pl. 38, figs. 1 and 2.

*Sp. Char.* Corallum from one and a-half to two lines wide; walls of the corallites thickened as they bend outwards from the imaginary axis to the surface; calices oval; intercalated cells very numerous, sometimes one row separating contiguous corallites, at other times three or four rows, and forming irregular maculæ; spines ornamenting the walls of the corallites few and irregularly disposed.

*Obs.* The specimen consists of a small portion of a corallum, partly in natural section and partly preserved in the round. It presents all the characters of Professor Nicholson's section *Heterotrypa*,\* and is nearly related to *M. (Heterotrypa) tumida* Phill. sp., especially the variety *miliaria*, Nicholson. Its delicate form and small size assist in distinguishing this coral.

*Loc. and Horizon.* Kooingal, near Gladstone (*The late James Smith*)—Gympie Beds.

## Genus—STENOPOREA, Lonsdale, 1844.

*Stenopora*, Lonsdale in Darwin's Geol. Obs. Volc. Islands, 1844, p. 161 (*note*).

„ Lonsdale in Strzelecki's Phys. Desc. New South Wales, &c., 1845, p. 262.

„ Nicholson and Etheridge fil., Ann. and Mag. Nat. Hist., 1879, iv., p. 265.

„ Nicholson, Tabulate Corals Pal. Period, 1879, p. 168.

„ Waagen and Wentzel, Pal. Indica (Salt Range Foss.), 1886, Ser. xiii., vol. i., Pt. 6, p. 885.

„ Etheridge fil., Mem. Geol. Survey N. S. Wales, Pal. No. 5, Pt. 1, 1891, p. 32.

*Obs.* The views held up to the present time on the structure of *Stenopora* will be found expressed in the works and memoirs quoted above. A general account of the history and structure of the genus and the Australian species will be found in the "Memoirs of the Geological Survey of New South Wales," as above indicated.

The descriptions of the three first species following is substantially the same as that given by Professor H. A. Nicholson and the Writer in the "Annals and Magazine of Natural History."

*Type*—*Stenopora tasmaniensis*, Lonsdale.

## STENOPOREA AUSTRALIS, Nicholson and Eth. fil., Pl. 6, figs. 5-8.

*Stenopora ovata*, Nich. and Eth. fil. (*non* Lonsdale), Ann. and Mag. Nat. Hist., 1879, iv., p. 271, f. 2a-o., p. 274, t. 14, f. 1-1c.

*Sp. Char.* Corallum sublobate or submassive, of cylindrical or flattened branches, which have a diameter of from less than two to more than three centimetres. Corallites vertical, or nearly so, in the centre of the branches but finally bending outward nearly at right angles and being continued for some distance in this direction before reaching the surface. Corallites in the central portions of the corallum thin-walled, polygonal, and closely contiguous; but in the horizontal portion of their course thickened by annular accretions, by which the tubes are placed in contact, the intervening, unthickened segments being free. Corallites on an average about one-third of a millimeter in diameter; tubes of smaller size being here and there intercalated among the larger ones. In the outer portion of the tubes, about six of the annular thickenings

\* Genus Monticulipora and its Sub-Genera, 1881, pp. 101 and 103.



of the tubes, and as many unthickened segments, occupy the space of one line. Tabulæ horizontal, sometimes complete, or at other times perforated by a central aperture, remote from one another as a general rule, and, for the most part, placed at corresponding levels in contiguous tubes, these levels having no evident relation to the annular thickenings of the tubes; acanthopores wanting.

*Obs.* The original specimens from the Bowen River Coal Field did not exhibit the surface in any manner that would enable the external characters of the species to be described. In identifying them with *S. ovata*, Lonsdale, we formerly relied chiefly upon the rapid divergence of the tubes from the central bundle, and the great number and close arrangement of the annular thickenings of the corallites in the horizontal portion of their course, these being sometimes so much developed as to give to the exterior of the tubes a regularly crenulated appearance. The annular thickenings are also unusually broad; and many smaller tubes are interpolated among the larger ones as the surface is approached.

In its minute structure, however, the present species differs widely from *S. ovata*, and resembles no other species of the genus known to us. One of the most marked characters of *S. australis*, in which it seems to stand alone among the species of *Stenopora*, is the total absence of acanthopores (Pl. 6, fig. 7). This character at once distinguishes the species from *S. ovata*, Lonsd. It agrees with the latter in the fact that the walls of contiguous corallites are completely amalgamated, the primordial wall only being visible in the axis of the branches, and also in the average size of the tubes; but the corallites are mostly more of a polygonal than of a simply rounded shape. As seen in longitudinal sections (Pl. 6, figs. 6 and 8), the corallites are thickened periodically, in the peripheral region of the corallum, by very regular fusiform thickenings placed at corresponding levels in contiguous tubes, as are also the tabulæ. As seen in long sections, the tabulæ appear to be complete; but, as viewed in tangential sections, appearances are seen which are difficult to explain, except upon the supposition that the tabulæ are perforated by a central aperture (Pl. 6, fig. 7). Thus in many of the corallites, as seen in tangential sections, we observe a broad ring of light-coloured sclerenchyma internal to the proper walls of the tube, and enclosing a central rounded aperture. What this ring is, unless it be a perforated tabula, it is difficult to see; but there is the curious feature that it is usually separated from the true wall for a portion of its extent on one side of the tube.

In our former description of this species (*loc. cit.*) we described and figured the above-mentioned singular structures, but were unable to give any explanation of their nature, as we believed the tabulæ to be imperforate. We are obliged to admit, however, that if this be their real nature they differ in some inexplicable points from ordinary perforated tabulæ. In *Stenopora Howsii*, Nich., the tabulæ are not only perforated by central apertures, but this fact is quite as easily recognizable in long sections as in tangential ones. In this form, however, the tabulæ are extremely numerous and the state of preservation is also very good. Mr. John Young has proposed the generic name of *Tabulipora* for a coral allied to or identical with *Stenopora Howsii*. In all other respects, however, save as regards its perforated tabulæ, *S. Howsii* does not differ from the normal species of *Stenopora*. If no other species of *Stenopora* possessed perforated tabulæ, there would be ground for accepting *Tabulipora* as a sub-genus of *Stenopora*, or perhaps as a distinct genus. If, on the other hand, the structures above described as occurring in *S. australis* are really perforated tabulæ, there does not seem to be any need for a special generic name. Moreover, it is only on the supposition that perforated tabulæ occur in the species of *Stenopora* generally, that we can account for Lonsdale's assertion that the mouths of the corallites in this genus are "closed at the final period

of growth." In most of the specimens we have examined (except *S. Howsii*) the surface is so badly preserved that the characters of the mouths of the tubes could not be accurately determined, and in some (such as *S. ovata*, Lonsd.), where the preservation of the surface was better, we have not been able to recognize any such closure of the mouths of the tubes. In one of the figures,\* however, which Lonsdale gives of *S. tasmaniensis*, the structure in question is well shown, and it corresponds entirely with what is seen in portions of the surface of *S. Howsii*, where it is undoubtedly the result of the existence of perforated tabulæ. We have ourselves observed the same structure in a single specimen of *S. tasmaniensis*.

*Loc. and Horizon.* Coral Creek, Bowen River (*R. L. Jack*)—Middle or Marine Series, Bowen River Coal Field.

*STENOPORA LEICHHARDTII*, *Nicholson and Eth. fl.*, Pl. 6, figs. 9 and 10; Pl. 7, fig. 2.

*Steropora Leichhardtii*, Nich. and Eth. fil., Ann. and Mag. Nat. Hist., 1886, xvii., p. 179, t. 3, figs. 7 and 8.

*Sp. Char.* Corallum dendroid, of cylindrical branching stems, which vary in diameter from less than a centimetre up to one and a-half centimetre. The corallites in the centre of the branches are nearly vertical, with comparatively thin walls, and polygonal in shape. In the peripheral region of the corallum, the corallites bend outwards nearly at right angles to the axis, the walls becoming thickened and being entirely fused with one another, while the visceral chambers become oval or rounded. The periodical thickenings of the walls of the tubes in the final portions of their course are mostly long and fusiform, and are generally placed at corresponding levels in contiguous corallites. The average diameter of the corallites is about one-fourth of a millimetre. In the walls of the corallites, in the peripheral region, acanthopores are developed in great numbers, their shape being usually oval or subangular, their size large, and their walls not specially, or only slightly, thickened. Tabulæ are very sparingly developed, and are only occasionally to be recognised at all.

*Obs.* In its general form this species closely resembles *S. ovata*, Lonsd., and the typical examples of *S. tasmaniensis*, Lonsd. From these two species, however, the present form is distinguished, among other characters, by the extraordinary abundance and large size of the acanthopores. *S. Howsii*, Nich., has also very numerous acanthopores, but these are for the most part very minute, and the annular thickenings of the wall are quite different, while the tabulæ are very numerous, and are perforated. The acanthopores are best seen in tangential sections (Pl. 6, fig. 9), but they are also well exhibited in sections of the peripheral region of the corallum, cutting the corallites longitudinally, in which they appear as delicate clear tubes running in the thickened walls of the corallites (Pl. 6, fig. 10). Tabulæ are often not to be detected, and when present are very few in number. In tangential sections appearances are occasionally to be detected, which may perhaps be caused by the existence of perforated tabulæ; but as the specimens are in a very peculiar condition of preservation, this cannot be affirmed with certainty. None of our specimens exhibit the surface of the corallum, and we therefore do not know if the mouths of the corallites were closed at the final period of growth by the development of a perforated tabula, as seems to have been sometimes the case in *S. tasmaniensis*, Lonsd., and probably in *S. australis*, nobis.

*Loc. and Horizon.* Pelican Creek, half-a-mile above Sonoma Road-crossing, Bowen River (*R. L. Jack*, and *E. Edelfelt*)—Middle or Marine Series, Bowen River Coal Field.

\* Strzelecki's Phys. Descrip. N. S. Wales, &c., Pl. 8, fig. 2b.

STENOPORA JACKII, *Nich. and Eth. fil.*, Pl. 6, figs. 11-13.

*Stenopora Jackii*, Nicholson and Eth. fil., Ann. and Mag. Nat. Hist., 1879, iv., p. 270, f. 1a-c, p. 275.

„ Nicholson, Tabulate Corals Pal. Period, 1879, p. 73, f. 25a-c.

„ Nicholson and Eth. fil., Ann. and Mag. Nat. Hist., 1886, xvii., p. 181.

*Sp. Char.* Corallum ramose, dividing at wide intervals, the branches cylindrical, averaging about two lines in diameter, and gradually tapering to their free extremities. The corallites are nearly vertical in the axial portion of their course, but ultimately bend outwards nearly at right angles to the imaginary axis of the branches, and open on the surface by rounded calices which are free from any obliquity. As the terminations of the branches are approached the angle of deflection of the corallites becomes less and less, and the horizontal portion becomes shorter and shorter, until at the extremity the whole of the corallites are nearly vertical. Average diameter of the corallites from  $\frac{1}{10}$  to  $\frac{1}{8}$  inch, smaller tubes being intercalated among those of average size as the surface is approached. Annular thickenings of the horizontal portions of the tubes narrow and ring-like, about five occupying one line, this being the total length, in general, of the annulated portions of the corallites. Surface not observed.

*Obs.* This is a graceful and well-marked species, easily distinguished from *S. ovata* and *S. tasmaniensis* of Lonsdale by its habit and general proportions. We should have been inclined to refer it to *Stenopora* (*Chaetetes*) *gracilis*, Dana, which it very closely resembles outwardly, had it not been for the fact that Dana lays stress upon the length of the tubes in the latter species, as well as upon the remarkable paucity of annulations in the same.

In the present species, on the other hand, the annulations of the tubes, in the horizontal portions of their course, are much more numerous than in *S. tasmaniensis*, Lonsd., while it differs conspicuously from *S. ovata*, Lonsd., and other species, in its size and general proportions. The presence of minute, irregularly placed mural pores was formerly believed to be readily made out in specimens which are longitudinally fractured, by an examination of the exterior of the tubes under low powers of the microscope. A study of additional specimens, however, in the Mining and Geological Museum, renders this point exceedingly doubtful, and it is more than probable that they do not exist.

The corallum of *S. Jackii* is from three to six millimetres wide, the latter just previous to bifurcation. Two tubes occupy the space of one millimetre, when seen in longitudinal section. The mode of growth seems to be very regular and characteristic in *S. Jackii*, the corallum bifurcating at wide intervals, and retaining a uniform thickness throughout, until quite near the apices of the branches, when it tapers off to a comparatively fine termination (Pl. 6, fig. 11).

*Loc. and Horizon.* Coral Creek, Bowen River (*R. L. Jack*)—Middle or Marine Series, Bowen River Coal Field.

It will be more convenient to describe here a Coral having many points in common with *S. Jackii*, but differing in one or two very important particulars. This is represented in our Pl. 7, figs. 3, 4, 5. The mode of growth is the same, repeated simple bifurcation at long intervals; the size of the corallum almost identical, from three to five millimetres in width; whilst two tubes similarly occupy the space of one millimetre. There is, however, this fundamental difference, that in this coral the tubes, although much thickened, are simple and apparently non-annulate. Since the figures were drawn I have had some excellent sections prepared, which demonstrate this feature in a very decided manner, and I hope in a Supplement to this Work to illustrate this form much more fully.

The dendroid corallum was evidently of some size, as a specimen has been observed three inches in length. The corallites radiate from an imaginary axis, and are thin-walled in the axial region, but very much thickened in the peripheral zone, which is short, and nearly at right angles to the former. The calices are round, or at times have a tendency to become oval. The thickening of the walls is very uniform and regular, the primordial wall occasionally being visible as an indistinct thin white line. String-like thickenings in the walls have not been observed, but this feature very much depends on preservation; whilst acanthopores are visible in a tangential section, irregularly distributed, and each with a central papilla. The structure of the walls is, as usual in these corals, laminar, the laminae directed convexly upwards. There are no pores, and tabulae have not been observed.

So well do the respective measurements of *S. Jackii* and the present coral agree, that I should have unhesitatingly referred the latter to the former had it not been for the total absence of tubular constrictions in this species. The differences observable in the figures of the two forms are more apparent than real.

At present my investigations have not satisfactorily demonstrated to what section of the larger genus *Monticulipora* this fossil should be referred; but, without entering into the question of the value of *Orbipora* as a genus, as lately defined by Messrs. Waagen and Wentzel,\* the latter would seem to be a fitting temporary resting-place.† As its provisional distinctness from *S. Jackii* seems warranted by the structure, so far as at present known, a name is desirable, and I would provisionally propose to call it *Orbipora? Waageni*, as a slight appreciation of the valuable services rendered to Palaeontology by Dr. W. Waagen, late of the Indian Geological Survey.

*Loc. and Horizon.* Kooingal, near Gladstone (*The late James Smith*)—Gympie Beds.

*STENOPORA GIMPIENSIS, sp. nov.*, Pl. 6, figs. 14 and 15.

*Stenopora? sp.*, Nicholson and Eth. fil., Ann. and Mag. Nat. Hist., 1879, iv., p. 276.

*Sp. Char.* Corallum ramose, the branches from two to five lines in diameter, diverging from a main stem obliquely, or at right angles, the terminal portions always bifurcating, and the apices of the branches rounded or lobate. The corallites, after a short vertical course in the axis of the branches, are abruptly deflected nearly at right angles; and after holding this latter course for a space of from half a line to a line or more, they open by direct apertures upon the surface. They are narrow but very constant in size; walls very uniformly and regularly thickened, the thickening increasing in amount as the calices are approached; structure is almost entirely destroyed, but the primordial wall is visible at times as a thin broken line; moniliform constrictions only visible in weathered specimens, the tubes always exhibiting in fractured specimens a very delicately and minutely wrinkled appearance. Acanthopores large, but obscure, irregularly arranged, and at times surrounding the calices. Tabulae present in the peripheral zone, although very much scattered, and rare, horizontal. No pores visible.

*Obs.* This coral was originally referred to *Stenopora*, by Professor Nicholson and the Writer, from general appearance only. We observed that though the coralla are calcareous, and are themselves permeated by crystalline calcite, their more delicate structures seem to have been destroyed during the process of fossilization, and microscopic sections fail to show the internal structure in a thoroughly satisfactory manner.

\* Pal. Indica (Salt Range Fossils), 1886, Ser. xiii., Vol. i., Pt. 6, p. 877.

† See Nicholson on the subject of the generic value of *Orbipora*. Genus *Monticulipora* and its Subgenera, 1881, pp. 11 and 24.

It was observed that the exterior of the tubes, in fractured specimens, was invariably delicately wrinkled in the peripheral regions; but the fortunate occurrence of a weathered and semi-decomposed specimen in Mr. De Vis' Collection, revealed the presence of very fine and regular moniliform constrictions of the genus. These do not seem to be visible in any other state, and are certainly not to be seen in thin sections, so far as our united observation has gone.

The corallum is usually from five to six millimetres wide, two tubes in the peripheral region occupying the space of one millimetre. The bifurcation is very regular, the branches always terminating in a lobato, or semi-plumose expansion. They possess this character to a much larger extent than any other *Stenopora*, and the individual branches are shorter. Herein lies a marked difference to Dana's illustration of his *Stenopora* (*Chaetetes*) *gracilis*,\* and an equally strong resemblance to his figure of *Stenopora ovata*, Lonsdale.†

The axial portion of the corallum is as correspondingly narrow, as the peripheral is wide, and the angle of deflection between the two is a most marked one, quite a right angle, the peripheral portion of the tubes being perfectly horizontal.

When compared with *Stenopora Jackii* the present species, *S. gimpiensis*, appears more robust, with stronger branches, and in place of the regular annulations, the exterior of the tubes is but faintly wrinkled. The stability of character displayed by this coral marks it as a good species, which I propose to call *Stenopora gimpiensis*, from its frequent occurrence in the rocks of that Goldfield. The figures (Pl. 6, figs. 14 and 15) are not eminently satisfactory, and it will be refigured in the Supplement to this Work.

*Loc. and Horizon.* Gympie, very characteristic of the green chloritic rock of the Goldfield (*The late R. Daintree*, Colln. Brit. Mus.; *R. L. Jack*; *C. W. De Vis*, Colln. Queensland Museum).

## Sub-Kingdom—ECHINODERMATA.

### Section—PELMATOZOA.

*Obs.* The remains of this division, with the exception of stem-joints, being of rare occurrence in the Palæozoic rocks of Queensland, and usually very fragmentary, it has been thought better to reproduce the whole hitherto collected, with the view of further identification in the future.

### Class—CRINOIDEA.

### Order—COADUNATA.

### Family—ACTINOCRINIDÆ.

### Genus—*ACTINOCRINUS*, Miller, 1821.

(Nat. Hist. Crinoidea, p. 90.)

### *ACTINOCRINUS*, *sp. ind.*, Pl. 7, fig. 9.

*Obs.* A cast of a few fragmentary plates, ornamented with tubercles and radiating ridges, is referred to this genus. A more complete, although not so well preserved specimen has been found by Mr. C. W. De Vis, in the neighbourhood of

\* Geology Wilkes' U. S. Explor. Exped., Atlas, t. 11, f. 10.

† *Ibid.*, t. 11, f. 9.

Rockhampton, with similarly ornamented plates. The calyx has been obliquely pressed to one side, and although obscure, the shallow basal cup and the succeeding radials can be fairly made out.

*Loc. and Horizon.* Corner Creek, Great Star River (*R. L. Jack*)—Star Beds; Rockhampton District \* (*C. W. De Vis*)—Gympie Beds.

### Family—PLATYCRINIDÆ.

*Genus*—*PLATYCRINUS*, *Miller*, 1821.

(*Nat. Hist. Crinoidea*, p. 73.)

*PLATYCRINUS* ? *NUX*, *sp. nov.*, Pl. 38, fig. 3.

*Sp. Char.* Calyx nut-shaped, length twenty-two millimetres, breadth fifteen millimetres. Basal plates forming a well pronounced, moderately deep cup, to some extent flattened on its articular or dorsal side; articular facet for stem-joint small. Radial plates oblong, gently convex, and straight-sided. The basals bear vertical, continuous, well-separated ridges, which are continued on the radials, and are most conspicuous on the distal two-thirds of the plates, where they spring from the basi-radial sutures especially.

*Obs.* The foregoing are the only facts which can be gained from this imperfect fossil, which appears to be an internal cast of the calyx. The long straight-sided radials are very apparent, and, with a rather similar basal cup, give to the calyx a nut-shaped outline, more particularly that of the hazel-nut. No other plates are preserved. It is provisionally referred to *Platycrinus* rather than *Dichocrinus*, to which it also bears some resemblance, but it must be admitted there is no trace of the articular margins along the ventral edges of the radials.

*Loc. and Horizon.* Richards' Homestead, three miles south-west of Mount Britton Township, Lat. S. 21° 20', Long. E. 148° 30' (*A. L. Morisset*)—Middle or Marine Series of the Bowen River Coal Field.

### Order—INADUNATA.

Family—POTERIOCRINIDÆ.

*BASAL-CUP OF CRINOID*, Pl. 44, fig. 7.

*Obs.* At first sight, this little cup has much the appearance of a *Platycrinite*, but is perhaps made properly referable to one of the *Encrinus*-like genera with a depressed or saucer-shaped calyx, such as *Ceriocrinus*, White, *Erisocrinus*, M. & W., or *Stemmatocrinus*, Trautschold. These are all Carboniferous genera, and mostly of rather late date in that formation.

The under-basals in our little specimen form a flat disc, pentagonal in outline, and apparently undivided. The basals seem to be pentagonal, and are, certainly, abruptly bent upward, "the lower portion included in the truncate surface, the upper almost vertical." These characters so strictly accord with those of *Stemmatocrinus*, that it is better to provisionally include this fragment in that genus.

*Loc. and Horizon.* Rockhampton District \* (*C. W. De Vis*)—Gympie Beds.

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\* See note, page 199.

Genus—*POTERIOCRINUS*, Miller, 1821.

(Nat. Hist. Crinoidea, p. 67.)

*POTERIOCRINUS*? *SMITHII*, *sp. nov.*, Pl. 8, fig. 1.

*Sp. Char.* Calyx five millimetres high up to the articulation of the second radials, and marked by strong longitudinal ridges, of which two are radial in position, and two interradial; the latter fork about the middle of the calyx, and the two branches of the fork are continued right and left to the articular facets on the radials. From these parts, therefore, three ridges proceed downwards, a radial one, and the right and left branch, respectively, of the interradial ridges on either side of it. The position of the basi-radial sutures is very obscure, but there seem to be indications of them at a comparatively short distance from the upper edge of the calyx, so that the radial plates would be relatively short, and the base high. The second radials are short, transverse, and oblong, but not as wide as the first radials; the third radials, or axillaries, are a trifle longer, and pentagonal in shape, each bearing three arms; the outer remains undivided, but the inner one consists of two joints (or first and second distichals), the second of which is axillary, and bears two arms; the latter are composed of relatively long and rounded quadrangular joints, with delicate pinnules. The stem consists of numerous discoid joints, three or four of which are larger than the others, and bear whorls of cirri.

*Obs.* This very interesting Crinoid is represented only by an impression on the surface of a piece of hard sandstone, and from which casts have been taken. The base is possibly dicyclic, but on this point the cast affords no definite information. The stem, so far as preserved, is long, and there are thirty-five internodal joints below the two lowest whorls of cirri, and about twenty in the next internode above.

The rather obscure state of preservation renders the reference of this Crinoid to *Poteriocrinus* open to doubt; it is, however, believed to belong to that genus. Many species of the latter appear to have whorls of cirri on the stem joints, especially near the top of the stem. The same is the case in *Hystericrinus*, Hinde, some species of *Belemnocrinus*, and a few other types. The only Neocrinoids with whorls of five cirri are the *Pentacrinidæ*.

I have much pleasure in associating with this interesting species\* the name of the late Mr. James Smith, of Rockhampton, who was instrumental in bringing to light many new fossils from that district.

*Loc. and Horizon.* Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

*POTERIOCRINUS CRASSUS*, Miller, Pl. 7, fig. 6.

*Poteriocrinus crassus*, Miller, Nat. Hist. Crinoidea, 1821, p. 68, plate.

" " T. and T. Austin, Mon. Recent and Foss. Crinoidea, 1843, p. 69, t. 8, f. 3a-m, t. 9, f. 1.  
" " De Koninck and Lehon, Mém. Acad. R. Belgique, 1854, Mém. 3, p. 97, t. 1, f. 10a-d.

*Obs.* Numerous impressions of stems, quite indistinguishable from those of this characteristic European Carboniferous species, were obtained by the late Mr. James Smith, associated with *Fenestella* and *Protoretepora*.

One specimen represents a portion of a stem, eight inches long, with a large number of strong cirri given off at close intervals.

Impressions of Crinoid stems appear to be very common in the Fenestella Beds around Stanwell, in all stages of preservation, and many good examples were collected by Mr. Smith.

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\* I am indebted for several suggestions on this species to the late Dr. P. H. Carpenter, F.R.S.

*Loc. and Horizon.* Encrinite Creek and Fenestella Hill, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

In addition to those just described, the following specimens have been collected, but are too imperfect to be definitely named :—

#### ARMS OF CRINOID, Pl. 7, fig. 7.

*Obs.* We have here the impressions of eight arms, or portions thereof, in their present condition covered with pores or small pits. These represent blunt spines or tubercles ornamenting the arm joints, such as are very well defined in some recent forms.

*Loc. and Horizon.* Stanwell, near Rockhampton (*The late James Smith*; Colln. Smith)—Gympie Beds.

#### ARMS OF CRINOID, Pl. 7, fig. 8.

*Obs.* In this specimen may be seen the remains of nine or ten arms of another Crinoid. In the centre is an axillary radial plate supporting two sets of five distichals, followed by two pentagonal plates as axillary distichals, giving support to two series of palmars. This succession is repeated in the series of plates on each side. This fossil may belong to one of the Ichthyocrinidæ.

*Loc. and Horizon.* Stony Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

#### IMPRESSION OF CRINOID CALYX, Pl. 44, fig. 8.

*Obs.* Pl. 44, fig. 8, represents a relief taken from an impression, on altered shale, of a portion of a Crinoid calyx, with the bases of small arms. Little or no trace of plates remain, but in the original the impression of the top stem-joint is visible. The late Dr. P. H. Carpenter, to whom a reproduction was sent, was disposed to refer it to the Platycrinidæ, from the above inequality in the plates and arms, amongst other characters.

*Loc. and Horizon.* Rockhampton District \* (*C. W. De Vis*)—Gympie Beds.

#### COLUMNS.

The remains of Crinoid stems have been obtained by Mr. W. Leigh, at Spring-sure, Central Railway; and by the late Mr. James Smith, plentifully, at Stony Creek, Stanwell, and at Kooingal. In the Athelstane Range, Rockhampton, the latter Collector found the remains of stems and corals, in an undeterminable condition, however, in a very peculiar oolitic and brecciated rock, containing grains of quartz, calcspar, felspar, &c., cemented by a calcareous base, and decomposing into a spongy, friable mass.

#### Class—BLASTOIDEA.

#### Order—REGULARES.†

#### Family—PENTREMITIDÆ.

*Genus*—*MESOBLASTUS*, *Eth. fl. and Carpenter*, 1886.

(Cat. Blastoidea Brit. Mus., p. 181.)

*MESOBLASTUS* ? *AUSTRALIS*, *Etheridge fl.*, Pl. 44, fig. 2.

*Sp. Char.* Calyx bi-pyramidal, tapering to both extremities; summit and base both small and narrow; periphery at the radio-deltoid suture. Basal plates forming a

\* See note, p. 199.

† Etheridge fl. and Carpenter—Catalogue of the Blastoidea in the Geological Department of the British Museum (Nat. Hist.), 1886, p. 148.



small conical cup. Radial plates oblong, and apparently spreading; bodies and limbs of nearly equal length. Sinuses long, narrow, parallel-sided, and nearly equally excavated between the radial and deltoid plates in two planes, the proximal or longer sloping away to the summit, the lower or distal directed towards the base, and shortest of the two. Radio-deltoid sutures strongly V-shaped. The deltoid plates are large, sharply lanceolate, and their surfaces probably a little concave. Ambulacra very long, narrow, parallel-sided; lancet plates slightly exposed; side plates small, at least forty on each side, ambulacral grooves rather deep, and much crenulated. Spiracles, hydrospires, and mouth unknown. Sculpture of radial and deltoid plates parallel to their outlines; that of the former consisting of ridges, separated by corresponding depressions; but on the latter the V-shaped lines become sub-imbricate.

*Obs.* I am constrained to place this anomalous form provisionally in *Mesoblastus*, although sensible that this is far from being its correct resting place. The general outline, contracted summit, and covered lancet plates, separate it at once from *Pentremites*, as that genus is now understood. The same characters indicate *Pentremitidea* as a near ally, but the large lanceolate deltoid plates quite forbid such a reference. The only other genus of the family Pentremitidae, the family to which the Blastoid clearly belongs, is *Mesoblastus*, E. and C. The resemblance between this genus and our species is so far identical that, in both, the deltoids are visible in a side view and conspicuous, the ambulacra narrow, without being linear in the sense as in the genus *Metablastus*, and there is to some slight extent a resemblance in form. In other features, on the other hand, *M. ? australis* does not conform to the structure of *Mesoblastus*, and it is possible that a new genus will be required for its reception. I am, however, not prepared to deny that it may not be an abnormal *Mesoblastus*, with both deltoids and base rather larger than usual in species of the latter.

A very peculiar feature is exhibited by this specimen, which, if real, and not superinduced by distortion or crushing, will separate it from all known Blastoids. At the radio-deltoid sutures the two outside ambulacra are bent down at a sharp angle, following the bi-pyramidal outline of the calyx. From the appearance of certain markings I was led at first to regard this as the result of fracture, but the bilateral symmetry, and undistorted state of the calyx would appear to indicate otherwise. To restore these ambulacra to the evenly convex outline found in Blastoids, in which the ambulacra extend beyond the periphery, would so disarrange the radial plates as to remove all semblance in the specimen to a Blastoid at all. I am therefore constrained to regard this angulation of the ambulacra as, to some extent, a feature of the species. This curvature is met with in several genera, *Mesoblastus*, *Schizoblastus*, and especially *Granatocrinus*, but not to such an extreme extent as in the present species.

I shall look forward with interest to the acquisition of further specimens, with the view of ascertaining how far this explanation of its structure holds good in *M. ? australis*.

*Loc. and Horizon.* Rockhampton District \* (*C. W. De Vis*)—Gympie Beds.

#### Family—GRANATOBLASTIDÆ.†

*Genus*—*GRANATOCRINUS*, Troost, 1849.

(*Amer. Jour. Sci.*, viii., p. 420; Emend., Etheridge fil. and Carpenter, Catalogue, *loc. cit.*, p. 238.)

*GRANATOCRINUS ? WACHSMUTHII*, *sp. nov.*, Pl. 7, fig. 10.

*Obs.* Under this name is figured the first discovered remains of an Australian Blastoid, and it affords me great pleasure to associate it with the name of Mr. Chas.

\* See note, p. 199.

† Etheridge fil. and Carpenter, Catalogue, *loc. cit.*, p. 237.

Wachsmuth, of Burlington, Iowa, to whom I was, in former years, in company with the late Dr. P. H. Carpenter, greatly indebted for very kind and exceptional assistance when working out the structure of the Blastoidea.

The specimen is only the partial impression of a calyx on a piece of indurated shale, but is still sufficient to show how distinct it is from either of the other Australian Blastoids. An ambulacrum is visible, containing a large number of plates, and highly ornate bounding plates. But whether these are radials, or large deltoids, after the type of *Granatocrinus derbiensis*, G. B. Sby.,\* it is difficult to say on account of the state of preservation, but probably the latter will be the correct reading. The summit seems to have been moderately large and truncate. Apparently a good deal of lateral pressure has taken place, otherwise it is difficult to account for the position and function of the large elongated plate immediately on the left (Pl. 7, fig. 10) of the radial sinus in the figure.

*Loc. and Horizon.* Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

#### Family—TROOSTOBLASTIDÆ.†

*Genus*—*TRICÆLOCRINUS*, Meek & Worthen, 1868.

(Proc. Acad. Nat. Sci. Philad., p. 356.)

*TRICÆLOCRINUS* ? *CARPENTERI*,‡ *sp. nov.*, Pl. 44, fig. 3.

*Sp. Char.* Calyx large, elongately barrel-shaped, or ovate, bi-pyramidal, attenuated both dorsally and ventrally; summit less contracted than is usual in this genus; base rather long, the excavations along the lines of the interbasal sutures wide and shallow, and extending as far as the radio-deltoid sutures; proximal or ventral section probably oval, or almost round, with rather rounded sides; distal or dorsal section indefinitely pentagonal, but more regularly so along a line drawn through the radial lips. Radial plates large, long, the lateral margins diverging, and giving an expanded appearance to the plates; bodies more than half the length of the limbs, moderately carinate; limbs narrowing upwards, their proximal margins very oblique; interradial sutures straight, in shallow concavities; radio-deltoid sutures deeply V-shaped, each half straight, sinuses long, narrow, and parallel-sided; radial lips but little marked. Deltoid plates large, elongately and unequally rhombic, more than one-third as long as the calyx. Ambulacra very narrow and of uniform width, the distal fourth not penetrating each radial plate; lancet plate long, narrow, and but very gradually tapering; hydrospires four on each side, pendent for three-fourths the length of the ambulacra, and probably retained within the substance of the radials for the remaining distal fourth.

*Obs.* The test, basal plates, mouth, and spiracles are not preserved. Although retaining all the general characters of *Tricælocrinus* but one, the calyx is much more oval and barrel-shaped than any described species of this peculiar genus. It departs entirely from the usual type in the possession of very large deltoids; but as those of *T. obliquatus*, Roemer, are not known, and those of *T. Meekianus* show an advance in size on the similar plates in the type species, *T. Woodmani*, I have determined for the

\* Etheridge fil. and Carpenter, Catalogue, *loc. cit.*, t. 9, f. 1 and 2.

† Etheridge fil. and Carpenter, Catalogue, *loc. cit.*, p. 190.

‡ The Writer desires to place on record his mite of testimony to the great loss Biology has sustained in the early and untimely death of his excellent Friend and Co-writer, Phillip Herbert Carpenter, D.Sc., F.R.S. No one amongst the latter's circle of acquaintance was probably in a better position to estimate the manly, upright, unselfish, and truthfully honest career of P. H. Carpenter than was the Writer, from his close association with him for many years in scientific work, and no one has certainly felt his decease more. (*R. E. Junr.*)

present to retain this species in the present genus. So far as its specific position is concerned it is unquestionably a new form. The large deltoids, and the fact of the radial sinuses being so largely enclosed by those plates, as well as the shallow basal excavations along the lines of the interrarial sutures, are points of the highest importance.

The structure of the ambulacra resembles that seen in *T. obliquatus*, Roemer. A little below the intersection of the sinuses by the radio-deltoid sutures, the impressions of the ambulacra on the surface of the cast abruptly cease. From these points, arguing by analogy, it is more than probable that they become enclosed within the substance of the radial plates. The surface of the cast below the visible terminations of the ambulacra is flattened and harpoon-head shaped, the apices representing the radial lips. At the proximal end of this depression are visible four hydrospire-sacs on each side, the outer ones becoming so much curved as to be almost at right angles to the ambulacra. The structure of this part of the economy of *T. Carpenteri* would seem to show that the hydrospires beneath the calyx plates were not cut off from the body cavity to the same extent as surmised by the late Dr. P. H. Carpenter and the Writer when describing the genus generally.\* A comparison with our figures † of the interior and exterior of the radial plates of *T. obliquatus* will fully demonstrate the point. This, no doubt, arises from the much greater development of the deltoid plates in the Australian species at the expense of the radials.

Structural details of the spiracles in *Tricælocrinus* are much needed, and I regret that the otherwise instructive cast now before me does not directly so assist. But I believe the hydrospire canals are visible in one of the interrarial areas, and partly so in a second. Their structure is not altogether clear, but it seems to be generally in accordance with that seen in the class.

*Loc. and Horizon.* Rockhampton District ‡ (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

## Section—ECHINOZOA.

### Class—ECHINOIDEA.

### Order—PALECHINOIDEA.

#### Family—ARCHÆOCIDARIDÆ.

#### *Genus*—ARCHÆCIDARIS, McCoy, 1884.

(Synop. Carb. Limest. Foss. Ireland, p. 173.)

*Obs.* The only evidence of the existence of this important group in the Palæozoic rocks of Queensland is the occurrence of a single plate, or rather the impression of it, in Mr. De Vis' Collection. The impression is, as usual, hexagonal, the margins granular, and the surface between the latter and the central tubercle flat. The latter is strong and well marked. It is certainly an interambulacral plate of a member of this family, and probably of the type genus. I believe this to be the first announcement of the occurrence of the Palechinoidea in Australian Permo-Carboniferous rocks.

*Loc. and Horizon.* Rockhampton District ‡ (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

\* Catalogue, *loc. cit.*, p. 205.

† *Ibid.*, t. 18, f. 10-13.

‡ See note, page 199.

## Sub-Kingdom—ANNULOSA.

## Class—CRUSTACEA.

## Order—OSTRACODA.

## Family—LEPERDITIDÆ.

Genus—*BEYRICHIA*, McCoy, 1846.

(Sil. Foss. Ireland, 1846, p. 57.)

*BEYRICHIA VARICOSA*, T. R. Jones, *sp. nov.*, Pl. 7, fig. 15.

*Obs.* "An internal cast of a right valve showing three main lobes as in *B. Klædeni*, but with differences. Thus the central lobe is nearly isolated: the two outer lobes are continuous below, and the hinder lobe is partially intersected from the dorsal edge, so that a small but definite supernumerary lobe is almost divided off from its inner (medial) ridge. The valve had a strongly flanged lip on its free margin, non-represented by a deep sloping furrow, stronger behind than in front. The dorsal and partly the anterior edge of the cast are obscured with matrix. Length of the valve two millimetres, height one millimetre."

On submitting this pretty little *Beyrichia* to Prof. T. R. Jones, F.R.S., he was kind enough to favour me with the above observations. He believes it to be distinct from any species of *Beyrichia* hitherto published, and it forms a welcome addition to the scanty Ostracod fauna, hitherto described from the Upper Palæozoic rocks of Australia.

*Loc. and Horizon.* Corner Creek, Great Star River (*R. L. Jack*)—Star Beds.

## Order—TRILOBITA.

## Family—PRÆTIDÆ.

Genus—*PHILLIPSIA*, Portlock, 1843.

(Report Geol. Londonderry, Tyrone, &amp;c., p. 305.)

*PHILLIPSIA DUBIA*, Etheridge, *sp.*

Pl. 7, fig. 12; Pl. 8, figs. 5 and 6; Pl. 44, fig. 4.

*Griffithides dubius*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., Pt. 3, p. 338, t. 18, f. 7.

*Sp. Char.* Body ovate-oblong, length about twice the width, sides parallel; general axis equal in width to the pleuræ; cephalic shield and pygidium about equal in length, but somewhat shorter than the body respectively. Cephalic shield semi-circular, with rounded genal angles, anterior border striate; glabella ovate pyriform, and narrowing towards the front, gently convex anteriorly, but rather flattened behind, not in any way overhanging the anterior edge of the shield; basal lobes prominent, rounded, and pea-like, deeply cut off by the neck furrow; basal furrows well marked, but the ocular furrows faint, oblique, and short, and the frontal furrows invisible; palpebral lobes but faintly developed, and narrow; free cheeks elongately triangular, with nearly vertical and delicately striate surrounding rim; eyes moderately long, and rather narrow, but most minutely faceted; neck furrow behind the glabella broad and deep. Thoracic

segments nine to ten; axis very distinct, and as wide as the pleuræ, with strong axial furrows; pleuræ much bent down, with wide and spatulate facets. Pygidium of ten segments, without any terminal spine; margin entire, nearly vertical, and striate; furrows of limbs wide and shallow. Testaceous sculpture unknown.

*Obs.* The above description is taken from a very perfect individual, collected by Mr. P. W. Pears, from which the test had been removed. The presence of the shelly matter would only modify the above expressions in but a slight degree.

The presence of the glabella furrows at once removes this species from *Griffithides*, and indicates *Phillipsia* as its proper resting place. It even appears to be peculiar amongst the species of this genus, for the remarkable diminution in width of the glabella forwards. Mr. R. Etheridge, F.R.S., described *P. dubia* as possessing from ten to twelve thoracic segments, but there appear to be only ten at the outside in the present specimen.

*Loc. and Horizon.* Don River, Queensland\* (*The late R. Daintree*)—Gympie Beds; Corner Creek, Great Star River (*R. L. Jack* and *P. W. Pears*)—Star Beds.

#### PHILLIPSIA WOODWARDI, *sp. nov.*

Pl. 7, figs. 11 and 13; Pl. 8, fig. 6; Pl. 44, figs. 5 and 6.

*Sp. Char.* Glabella round, without any lateral inflection of the margin, moderately convex in the middle line, and a little arched posteriorly; neck furrow strong and deep, with more or less complete basal furrows; anterior furrows present, but faint; anterior border thick and upwardly turned, leaving a wide depression between it and the front of the glabella.

*Obs.* This is a much larger and rounder form than *P. dubia*; but the marked feature is the upwardly turned front rim to the head, separated from the front of the glabella, a character sometimes met with in this genus, but not often, as the border is usually confined to the immediate front edge of the glabella. In general appearance *P. Woodwardi* resembles some species of the allied genus *Prætus*, and in its remarkable rotundity *Cheirurus*.

The glabella of *P. Woodwardi* may be distinguished from that of *P. dubia* by its continuous and non-indented outline.

The pygidium referred to is much larger than that described as *P. dubia*, but otherwise resembles it; and again only differs from the Trilobite figured by Dr. Koninck as *Griffithides Eichwaldi* in having a rather narrower axis; in fact it is quite possible that the two may be identical. De Koninck's reference of a New South Wales Trilobite to that species is, I believe, erroneous. The pygidium he figures is much too round for *G. Eichwaldi*, and not so long from before backwards, being more semi-circular and less deltoid.

*Loc. and Horizon.* Stony Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

#### PHILLIPSIA? *sp. ind.*

*Obs.* Portions of the largest Permo-Carboniferous Trilobite I have yet seen from Australia were collected by the late Mr. James Smith, in the neighbourhood of Mount Morgan. It is the half of a pygidium, measuring across the anterior end, from the border of the pleura to the centre of the axis, exactly half-an-inch, giving one inch as

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\* The Don River referred to by Mr. Etheridge must be the tributary of the Dawson of that name—(Lat. 24° S., Long. 150° 20' E.) It cannot be the Don River near Bowen. (*R.L.J.*)

the full width of the pygidium. The specimen is quite decorticated and without test. There are fourteen to sixteen pleuræ visible, the anterior ones rather sigmoidal in outline. The perfect tail was probably broad oval, or shield-shaped, and many of the pleural grooves are wide and open.

This fossil is, in all probability, undescribed, and its imperfect condition is to be regretted. If new, I would propose for it the name of *Phillipsia? grandis*. It will be figured in a separate Paper on Queensland fossils.

*Loc. and Horizon.* West of the Dividing Range, at the Crow's Nest, near Mount Victoria, near Mount Morgan (*The late James Smith*; Mining and Geol. Mus., Sydney)—Gympie Beds.

*Genus—GRIFFITHIDES, Portlock, 1843.*

(Geol. Report, Londonderry, &c., p. 310.)

*GRIFFITHIDES SEMINIFERUS, Phillips, sp. ?, Pl. 7, fig. 14.*

*Asaphus seminiferus*, Phillips, Ill. Geol. York, 1836, Pt. 2, p. 240, t. 22, f. 8-10.

*Phillipsia seminifera*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 348, t. 24, f. 9 and 9a.

*Griffithides seminiferus*, Woodward, Mon. Brit. Carb. Trilobites, 1883, Pt. 1, p. 28, t. 28, f. 1-9.

*Obs.* A Trilobite, in many features resembling this species, has been obtained at two localities. At one it is represented only by a small free cheek (Pl. 17, fig. 14), but possessing the same ornament, and generally resembling De Koninck's figure, as above given. The other specimens consist of portions of two individuals much displaced, but clearly showing that from ten to eleven thoracic rings existed, very convex and rounded. The glabella was short and semi-circular, broad and densely granuled, the basal lobes large, and the lateral terminations of the pleuræ large and spathulate. The limb of the glabella and pygidium was striate.

Although otherwise corresponding with *G. seminiferus*, the latter has the advantage of size, and the limbs are plain. This, however, I opine, can hardly constitute a specific difference, but it may perhaps render our form a good variety, and it may be known as *G. seminiferus*, var. *australasica*.

*Loc. and Horizon.* Stony Creek, Stanwell (*The late James Smith*); Rockhampton District \* (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

Sub-Kingdom—MOLLUSCA.

Class—POLYZOA.

*Obs.* The determination of fossils of this class found in the Upper Palæozoic rocks of Eastern Australia is rendered exceedingly difficult by their imperfect state of preservation, found, as they usually are, merely in the condition of impressions. In such specimens the whole of the substance of the polyzoarium has been removed, leaving usually not the slightest trace of the cells, but is merely represented by the hollow spaces from which the stems and branches have disappeared, and the cast of the mesh-like fenestrules. This state of preservation has rendered identification very difficult, a difficulty not decreased by the obviously perplexing manner in which the characters of the species appear to run into one another. In the absence of definite information concerning the nature of the cells, it becomes very difficult to distinguish between species, so little reliance can be placed upon the size and relative distance apart of the meshes of the polyzoarium.

\* See note, p. 199.

Since my remarks on the Polyzoa of the Bowen River Coal Field were written,\* I have succeeded in finding† the original specimens collected by the late Count P. de Strzelecki, and figured by the late Prof. Morris in the work of the former, and am therefore able to form a much better conception of the species.

## Order—GYMNOLEMATA.

### Sub-Order—CYCLOSTOMATA.

#### Family—FENESTELLIDÆ.

#### Genus—*FENESTELLA*, Lonsdale, 1839.

(Murchison's Silurian System, p. 677.)

#### *FENESTELLA FOSSULA*, Lonsdale, Pl. 9, figs. 4 and 5.

*Fenestella fossula*, Lonsdale in Darwin's Geol. Obs. Volc. Islands, 1844, p. 166.

" " Lonsdale in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 269, t. 9, f. 1.

" " Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii. Pt. 1, p. 332, t. 25, f. 1.

" *plebeia* (pars), Etheridge fil., Cat. Australian Foss., 1878, p. 43.

" *sp. ind.*, Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 279.

*Sp. Char.* Polyzoarium infundibuliform, curled on the upper surface, structure very regular. Interstices and dissepiments remarkably regular, fine, slender, or almost hair-like, the former with a fine median keel, and branching dichotomously, but rarely. Cells very small, increasing to three rows below each bifurcation of an interstice, and from three to four corresponding to each fenestrule in vertical series, one being usually placed opposite the end of each dissepiment. Fenestrules square-oval. Reverse face usually striate granular.

*Obs.* In the "Catalogue of Australian Fossils" I included *F. fossula* as a synonym of *F. plebeia*, McCoy, chiefly in deference to the opinion of Prof. L. G. de Koninck.‡ After examining the Strzeleckian type in the National Collection, however, I am unable to support this view, and believe that *F. fossula* will prove distinct from McCoy's species.

The general appearance is quite different to that of *F. plebeia*. It is relatively much smaller and finer, the interstices more closely packed together, giving rise to that appearance which suggested to Mr. R. Etheridge, F.R.S., the name of *F. densa*.§ There is a total absence of the erect, rigid, and wiry appearance so common to *F. plebeia*.

In describing *F. fossula*, Lonsdale distinctly says, "Celluliferous face internal," and several exceedingly good specimens in the Mining and Geological Museum, Sydney, show the curled and infundibuliform expansion to be so, and the branches only celluliferous. The rows of zoecia vary from two to five, usually the former, but sometimes three rows predominate. The increase, however, usually takes place on a branch about to bifurcate, and the rows are invariably separated by keels or longitudinal dividing ridges. Both this and the succeeding species quite lack the rigid, wiry look of *Polypora*.

*Fenestella jabiensis*, Waagen and Pichl,|| from the Salt Range, is very closely allied to this, judging from the fragments figured, but is perhaps of rather too large a habit.

\* Proc. R. Phys. Soc. Edinb., 1880, v., p. 273.

† In the Geological Department of the British Museum (Natural History), London.

‡ Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 171.

§ Quart. Journ. Geol. Soc., 1872, xxviii., p. 332.

|| Pal. Indica (Salt Range Foss.), 1885, Ser. xiii., Pt. 1, No. 5, p. 778, t. 88, ff. 1a-d and 2.

**Loc and Horizon.** Smithfield Reef, Gympie, and Blackfellows' Diggings, Rockhampton (*The late R Daintree*; Colln. Geol. Surv., Queensland, and British Museum)—Gympie Beds; Coral Creek, below Sonoma Road-crossing, and Stone-humpy Creek, Bowen River (*R. L. Jack*)—Middle or Marine Series, Bowen River Coal Field; Lake's Creek, near Rockhampton (*The late James Smith*)—Gympie Beds.

**FENESTELLA INTERNATA, Lonsdale, Pl. 9, figs. 6 and 7.**

*Fenestella internata*, Lonsdale in Darwin's Geol. Obs. Volc. Islands, 1844, p. 165.

" " Lonsdale in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 269, t. 9, ff. 2, 2a-c.

" " Dana in Geology Wilkes' U. S. Explor. Exped., 1849, p. 710, atlas, t. 10, f. 13a-b.

**Sp. Char.** Polyzoarium infundibuliform, regular in appearance. Interstices narrow, straight, medianly keeled and sometimes tuberculate, and frequently dichotomising; dissepiments short, of less breadth than the interstices. Fenestrules oval. Cells round, three to a fenestrule, two being situated on each margin, and one opposite the dissepiments on each side. Reverse granular-striate.

**Obs.** *F. internata* appears to differ from *F. fossula* only in being of a larger habit, and although a regular closely knit species it does possess the same densely retiform appearance. In the case of this species, Lonsdale again distinctly says that the celluliferous face is internal. The examples from Queensland, like the type, are casts only, or rather impressions left by the removal or decay of the polyzoarium. In such instances it is exceedingly difficult, even with the aid of squeezes in relief, taken from them, to express with accuracy the characters of the fossil under description. When only two rows of zoecia exist on the branches of this species, the dividing keel is straight and sharp; but when the latter is augmented they become less defined and wavy. This is equally visible in Tasmanian specimens.

**Loc. and Horizon.** Fenestella Hill, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

**FENESTELLA, sp. ind.**

*Fenestella, sp. ind.*, Etheridge fil., Trans. R. Soc. Vict., 1876, xii., p. 68, pl., f. 2 and 2a.

**Obs.** This form bears a resemblance to Lonsdale's *F. internata*, but it is apparently too large in habit, and the number of cells in a given space is too great. It was evidently a large and handsome species. The interstices are carinate, and the cells from four to six within the length of a fenestrule; the latter appear to have been oval. In places a third row of cells is developed, especially previous to the bifurcation of the interstices. Only one specimen has been examined.

**Loc. and Horizon.** Gympie (*The late R. Daintree*; Colln. British Museum). *Fenestella* has also been obtained at Kooingal (*The late James Smith*)—Gympie Beds.

**FENESTELLA MULTIPORATA, De Koninck, Pl. 8, figs. 7 and 8.**

*Fenestella multiporata*, De Koninck (non McCoy), Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 175, t. 8, f. 1.

**Obs.** A small and pretty *Fenestella*, corresponding with the *F. multiporata* of De Koninck, but not of McCoy.\* Both De Koninck's illustration, and the present specimen, although possessing the same number of cells to a fenestrule as McCoy's species, differ wholly from the latter in the small size and habit of the polyzoarium. This is certainly the case as regards Prof. De Koninck's figure, notwithstanding his very positive assertions to the contrary.

\* Synop. Carb. Limest. Foss. Ireland, 1844, p. 203.



The identity of many of De Koninck's species is rendered very difficult by the careless mistakes which are made in the reference-numbers of the figures given in the text, and in the Plate-Explanations. The present is a case in point—in the text *F. multiporata* is said to be Pl. viii., fig. 4, when it should be fig. 1.

The polyzoarium of this species would seem to have been fan-shaped, and certainly its features are very minute and delicate. The length of the fenestrule will at once distinguish it from *F. fossula*.

*Loc. and Horizon.* Corner Creek, Great Star River (*R. L. Jack*)—Star Beds.

*Genus*—*POLYPORA*, *McCoy*, 1844.

(Synop. Carb. Limest. Foss. Ireland, p. 206.)

*POLYPORA* ? *SMITHII*, *sp. nov.*, Pl. 9, figs. 1-3; Pl. 44, figs. 9 and 10.

*Sp. Char.* Polyzoarium crumpled and curled, and probably infundibuliform, composed of very straight, rigid, and regular interstices, bifurcating at long intervals, and retaining the same width throughout. Dissepiments short, thin, and also very regular. Fenestrules narrow, and long-oval. Cell-mouths arranged in three or four oblique rows across the interstices. Reverse with very fine and regular longitudinal striæ, or occasionally granular striate.

*Obs.* A tendency to wide bifurcation, accompanied by the erect habit, give to this form a fan-like appearance, producing a very marked character. The several rows of cell apertures on the interstices, and their absence on the dissepiments, appear to indicate this as a species of *Polypora*. The fan-shaped polyzoarium is crumpled and curled to some extent; but at present no satisfactory evidence can be adduced to show that the poriferous face was internal, as in *Protoretepora*. It is provisionally, therefore, referred to *Polypora*. I have seen this interesting Polyzoon from two localities in Queensland, but from one of them, Fenestella Hill, Stanwell, there are large fronds of a somewhat smaller habit, which may be only a variety.

*P. ? Smithii* partakes of the habit of *P. gigantea*, Waagen and Pichl,\* but is decidedly smaller in all its parts; neither does it correspond to the close retiform or *Phyllopora*-like species usually met with in the Carboniferous rocks of other areas. *P. ? Smithii* will require further working out from additional and better preserved material.

An impression (Pl. 44, figs. 9 and 10) of the poriferous face of a stiff and somewhat rigid form has been obtained at Gympie by Mr. W. H. Rands. The fenestrules are long and narrow, the interstices erect, straight, and thin. The dissepiments are small and short, whilst the cells vary from six to nine to a fenestrule, three alternating rows on each interstice, with prominent exsert mouths. The obverse surface is delicately striate.

*Loc. and Horizon.* Blackfellows' Diggings, near Rockhampton (*The late R. Daintree*; Colln. Brit. Mus.); Fenestella Hill, Stanwell, near Rockhampton (*The late James Smith*); Hill near Nos. 7 and 8, Lady Mary Reef, Gympie (*W. H. Rands*)—Gympie Beds (Pl. 44, figs. 9 and 10.)

*Genus*—*PROTORETEPORA*, *De Koninck*, 1877.

*Protoretepora*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 178.

„ Etheridge fil., Proc. R. Phys. Soc. Edinb. 1880, v., p. 275.

*Gen. Char.* Polyzoarium infundibuliform, pedunculated, frequently of large extent, forming either a simple funnel-shaped expansion, sometimes wavy along its

\* Pal. Indica (Salt Range Foss.), 1885, Ser. xiii., Pt. 1, No. 5, t. 89, f. 1 and 2.

upper margin, or one much crumpled, contorted, and curled. Dissepiments and interstices but little differentiated (except by the much greater breadth of those portions representing the former), more or less coalescent and the interstices many times dichotomous. Fenestrules numerous, oval or round, arranged in regular vertical series. Celluliferous surface internal, the dissepiments usually cell-bearing. Basal plate thin. Outer surface striate or granular.

*Obs.* The names *Fenestella* and *Polypora* had been indiscriminately used by some Writers for colonies which really possess the characters of *Phyllopora*, except that the cell-bearing face, or aspect of the polyzoarium, was internal instead of external, as expressly stated by Professor W. King in the case of his genus. It is for these infundibuliform and intermediate *Phyllopora*-like forms that Professor L. G. De Koninck has proposed his genus *Protoretepora*. In a few words it may be said to differ from allied genera, as follows:—From *Fenestella*, by having the whole of one face of the polyzoarium cell-bearing, and that the internal instead of either the internal or external, and the cells not limited to the interstices only; from *Polypora*, by the absence of a well-defined separation of the polyzoarium into interstices and dissepiments, and the whole of the cell-bearing face celluliferous; lastly, from *Phyllopora*, simply by the fact that the celluliferous aspect is internal, and not external, the arrangement and disposition of the cells being exactly the same.

*Protoretepora* would at first sight appear to have close relations to the recent *Retepora*, and it appears that the only reason assigned for their separation by Professor De Koninck scarcely seems sufficient. He says that “in *Retepora*, properly speaking, the branches are arranged (*contournées*) in such a way as to form meshes, and not regular rows of ‘oscles’ or fenestrules” (*i.e.*, as in *Protoretepora*).

After examining carefully a specimen of the recent *Retepora Beaniana* (King), one cannot see that the difference pointed out by Prof. De Koninck is of sufficient importance in itself to base a generic separation on. On the other hand, if we look a little more minutely into the subject, we shall find a much more satisfactory reason for the separation of the two forms.

Lonsdale long ago pointed out in describing \* his *Fenestella ampla*, that the polyzoarium was bilamellar, the outer layer or back of the branches being “composed of a uniform crust,” upon which are seated the tubular cells, at right angles, or a little obliquely to the former. This structure is exceedingly well shown in Mr. Lonsdale’s figure given in Count Strzelecki’s work,† but we are indebted for a further and fuller exposition of it to Professor W. King. This Author showed ‡ that in his genus *Phyllopora*, and some other Palæozoic genera, the frond was bilamellar or bistructural, consisting of a lamina of capillary tubes, called the basal plate, and an outer lamina of cellules, arranged more or less at right angles to, and on this. On the other hand, he states that in the Elasmoporidæ (=Reteporidæ, Auct.), the frond is uni-lamello-celluliferous, “composed of one lamina, consisting simply of cellules or polypidoms.” As before stated, this bilamellar structure has been shown to exist in *Protoretepora ampla*, by Lonsdale, and it appears to me a character of much more generic value than the mere arrangement of the fenestrules only.

The distinction between *Fenestella* and *Protoretepora* is even more than a generic one, it is even that of a sub-family. In the former the cells are arranged in regular rows on each side, a prominent keel traversing every branch. In the later genus the

\* Darwin’s Geol. Obs. Volc. Islands, pp. 163, 164.

† Phys. Descrip. N. S. Wales, &c., 1845, t. 9, f. 3d.

‡ Ann. and Mag. Nat. Hist., 1849, pp. 388-90; Mon. Perm. Foss. England, 1852, p. 42.

whole of the branch surfaces are celluliferous without any separation by ridges. The separation of the two genera is not a question of which aspect of the polyzoarium is cell-bearing, but of the arrangement of these cells on the branches.

It is, however, to *Polypora*, as pointed out by Dr. Waagen, as well as to *Phyllopora*, that *Protoretepora* is most nearly allied. Here the arrangement of the cells on the interstices is identical, the only question being as to which aspect of the polyzoarium is celluliferous. In *Protoretepora* it is undoubtedly the inner. I quite agree with Dr. Waagen as to the close affinity of *Polypora* and *Protoretepora*; but before they can be united it must be shown that in the type species on which McCoy established the former, the polyzoarium is celluliferous on the inner face, and in consequence therefore infundibuliform. Until this is demonstrated *Protoretepora* can be satisfactorily made use of as a genus. I cannot agree with Dr. Waagen that the question of this, or that face being cell-bearing, is one of accident. He says—"The sole difference between the two consisting in the circumstance, that in the one the pores are said to be placed on the inner, in the other on the outer side of the funnel-shaped colony. Such a position of the pores is evidently only accidental, depending upon the mode in which the quite young and still fan-shaped colony first became twisted; if towards the poriferous side the pores remained on the inner side, if in the reverse direction the pores remained outside."\* That "the position of the pores is evidently accidental" is pure assumption, and it has yet to be proved that these infundibuliform genera commenced life as a "still fan-shaped colony," and not with a miniature infundibuliform or cup-shaped outline. I much question if the mode of growth is not a regular and constant factor in the anatomical construction of such genera. It certainly is constant in a large number of recent Polyzoa, examined for the purpose by Mr. T. Whitelegge, of the Australian Museum, and the Writer. Taking *Retepora* as an example of the more or less infundibuliform solitary polyzoaria, we found that the inner aspect was invariably celluliferous in both *R. monilifera*, Macq., the Port Phillip form, and *R. jacksoniensis*, Busk., inhabiting Port Jackson, and the outer side of the polyzoarium never. The same is the case in such tube-like species as *Mucronella delicatula*, Busk., and *M. bisinuata*, Smith, from Thursday Island, and also *Schizoporella australis*, Hasw. The fact is again repeated in the sub-dendroid species of *Cellepora*, and in saucer-shaped polyzoaria, like *Carbasea cribiformis*.

One very essential character ascribed by De Koninck to his genus appears to have been overlooked by Dr. Waagen. The former says of *Protoretepora*, "toute la surface interne est ornée de plusieurs lignes de petites cellules." Now, whatever the celluliferous aspect may have to do with generic separation, we have here a feature, which on Dr. Waagen's own showing is of importance, for, he says, speaking of *Polypora*, "the pores restricted to the branches." Until, therefore, McCoy's type species of *Polypora* can be shown to be celluliferous on the inner aspect, and in the case of both *Phyllopora* and *Polypora* on the dissepiments as well as the interstices, De Koninck's genus can retain its rank as such.

#### PROTORETEPORA AMPLA, Lonsdale, sp.

*Fenestella ampla*, Lonsdale in Darwin's Geol. Obs. Volc. Islands, 1844, p. 163.

" Lonsdale in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 268, t. 9, ff. 3a-d.

" Dana, Geology Wilkes' U. S. Explor. Exped., 1849, p. 710, t. 11, ff. 1 and 1a.

*Polypora ampla*, Etheridge fil., Trans. R. Soc. Vict., 1876, xii., p. 66, Pl., f. 1.

*Protoretepora ampla* (pars), Etheridge fil., Cat. Australian Foss., 1878, p. 45.

*Sp. Char.* Polyzoarium funnel or cup-shaped, with the upper portions more or less crumpled. Interstices broad, flattened, and expanding previous to bifurcation; dissepiments short, sometimes celluliferous. Fenestrules oval, and rather long, the

\* Pal. Indica (Salt Range Foss.), 1885, Ser. xiii., No. 1, fasc. 5, p. 775.

margins sometimes irregular, or wavy from the projection of the lateral rows of cell-mouths. Cellules round, exsert, in from three to ten oblique rows, separated by slightly impressed lines or grooves. Outer surface of polyzoarium granular-striate.

*Obs.* In a former Paper \* it was shown that my Colleague had collected three well-marked forms of retiform Polyzoa from the Carboniferous rocks of Northern Queensland. One of these was a large crumpled form, to which the name *Protoretepora Koninckii* was given; the second was stated to be allied to *P. ampla*, but smaller in habit; whilst the third was *Fenestella fossula*, Lonsd. At the same time the great difficulty attending the satisfactory determination and separation of these species was pointed out.

Since the remarks referred to were written, I have found, in the National Collection,† Strzelecki's types of *P. ampla*, *Fenestella fossula*, and *F. internata*, described by Lonsdale. A comparison of these types with the Queensland specimens has rendered a revision of the names applied to the latter necessary. In the first place the coarse form called *P. Koninckii* can only be regarded as an extreme variety of the typical *P. ampla*. Secondly, the fossil compared to the latter is another variety, but in the opposite direction to *P. Koninckii*, being of a finer and smaller habit; whilst, in the last place, the fossil called *Fenestella fossula*, I believe to be that species.

The leading features of *Protoretepora ampla*, therefore, are the coarseness of its mesh, and the want of clear demarcation between the dissepiments and interstices. The former varies in its greatest extent towards the var. *Koninckii*, and in the least degree towards the other condition, which will be immediately described as the var. *Woodsii*.

*Loc. and Horizon.* Blackfellows' Diggings, near Rockhampton (*The late R. Daintree*; Colln. British Museum); Gympie (*R. L. Jack*); Foot of Broadsound Ranges, between Maxford and Apia Creek, about Lat. 22° 52' S., and Long. 149° 34' E. (*J. M. Kaufmann*)—Gympie Beds.

PROTORETEPORA AMPLA, var. WOODSII, var. nov., Pl. 8, fig. 12.

*Protoretepora ampla*, De Koninck (non Lonsdale), Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 180, t. 8, f. 5a-c.

„ *sp. ind.*, Etheridge fil., Proc. R. Phys. Soc. Edinb. 1880, v., p. 278.

*Obs.* As before stated, this name is applied to that form believed to be a small variety of *P. ampla*, and typified by Prof. De Koninck's figure, which is certainly not that of the species proper. The entire habit of the polyzoarium is on a smaller scale than that of Lonsdale's type specimen, but the details of structure are otherwise identical.

*Loc. and Horizon.* Coral Creek, below Sonoma Road-crossing, Bowen River (*R. L. Jack*)—Middle or Marine Series of the Bowen River Coal Field.

PROTORETEPORA AMPLA, var. KONINCKII, Etheridge fil.

*Protoretepora Koninckii*, Etheridge fil., Proc. R. Phys. Soc. Edinb. 1880, v., p. 277.

*Obs.* The polyzoarium is infundibuliform, curled, and much crumpled, and of large extent. The fenestrules are small, round, separated by wide interspaces (interstitial), and arranged in quincunx. Interstitial surface occupied by from five to ten rows of cell-apertures between contiguous fenestrules. Cells with hexagonal or polygonal bases. Basal plate thin and striated.

The fenestrules are smaller than in typical specimens of *P. ampla*, Lonsdale, but the increased interstitial surface separating the circular fenestrules gives to *P. ampla*,

\* Proc. R. Phys. Soc. Edinb., 1880, v., p. 274.

† In the Geological Department, British Museum (Natural History), London.

var. *Koninckii*, a very marked appearance, which is still further increased by the large extent of the curled and crumpled infundibuliform frond, with its numerous ramifications, displayed to great advantage in the nodular matrix in which it is entombed.

*Loc. and Horizon.* Coral Creek, below Sonoma Road-crossing, Bowen River, in a decomposed nodular ironstone, associated with *Stenopora*, and numerous other fossils (*B. L. Jack*)—Middle or Marine Series of the Bowen River Coal Field.

#### Family—THAMNISCIDÆ.

##### Genus—*GLAUCONOME* (*Münster*), *Lonsdale*, 1839.\*

(*Münster* in Goldfuss. *Petrefacta Germaniæ*, 1826, i., p. 217; restricted, *Lonsdale*, *Murchison's Silurian Syst.*, 1839, p. 677.)

*Obs.* In "Notes on Carboniferous Polyzoa,"† I have fully discussed the value of the generic name *Glaucome* and re-defined it. Since my remarks were made, Mr. G. B. Vine has proposed a new genus ‡ to take the place of the present one, but it seems to me on very insufficient grounds. After a careful perusal of his remarks, I am quite unable, with the present means at my disposal, to comprehend his very disjointed and indefinite Memoir.

*GLAUCOME*, *sp. ind.*, Pl. 44, fig. 11.

*Obs.* But a single specimen of this genus has come under my notice amongst the Queensland fossils, and that is only a fragment. It consists of a main stem, with two primary branches, which are pinnate, with supplementary branchlets between them; but as only the reverse, or non-celluliferous face is presented to view, the species cannot be determined.

*Loc. and Horizon.* Rockhampton District § (*C. W. De Vis*; Colln. *De Vis*)—Gympie Beds.

#### Family—PETALOPORIDÆ.||

*Obs.* Mr. E. O. Ulrich ¶ has included the genus *Rhombopora*, Meek, in the *Rhabdomesontidæ*, with the peculiar genus *Rhabdomeson*, Young and Young, and it seems to me very improperly so. *Rhabdomeson* is one of the few Polyzoa possessing a solid axis. This is also known to exist in the living *Rhabdopleura*, Allman, and, according to Ulrich, is again met with in two other Palæozoic genera, *Caloclema*, Ulrich, and *Cheilotrypa*, Ulrich.

The presence of a cylindrical chitinous rod in *Rhabdopleura* has been thought of sufficient importance, together with other characters, to warrant the erection not only of a separate family, but even of a distinct class for its reception. The remarks of Dr.

\* *Non Glaucome*, Gray, 1828, a genus of Pelecypoda.

† *Ann. and Mag. Nat. Hist.*, 1877, xx., p. 30.

‡ *Brit. Assoc. Report for 1883* [1884], p. 191. Whilst referring to this "Report," I wish to correct two very unnecessary errors into which Mr. Vine has fallen with regard to species of mine. Under *Thamniscus* (p. 195), is mentioned *T. Rankinei*, Young and Young. Had Mr. Vine paid the slightest attention to my paper quoted above, and which he mentions in his bibliography, he would have found this to be a synonym of my *Thamniscus pustulata*, at one time described by me as *Polypora*. I there entered fully into this subject, showing how the Messrs. Young, of Glasgow, had fallen into the same mistake. The next point is that a remarkably good species of *Fenestella*, described by me as *F. scotica*, is relegated, solely on Mr. Vine's authority, to another of my species, *F. tuberculocarinata*, as a synonym. It is almost needless to remark that they are distinct.

§ See note, p. 199.

|| *Petaloporidae*, Waagen.

¶ *Journ. Cincinnati Soc. Nat. Hist.*, 1884, vii., p. 24.

Hincks,\* in his description of *Rhabdopleura*, bear very pertinently on this point. He says—"The relation of the polypide to its dwelling in *Rhabdopleura* is totally unlike that to which we are accustomed in the ordinary polyzoon. . . . The polypide is therefore wholly unconnected with its cell. . . . Its only connection is with a cylindrical chitinous rod, enclosing a soft cellular core, and traversing the whole of the adherent portion of the zoarium."

This anomalous structure is not present in *Rhombopora*, and I must confess to being quite at fault in attempting to account for Mr. Ulrich's reason for placing such widely different genera in the same family. Under these circumstances the above family is adopted after Waagen.

By Zittel† this genus has been placed in the *Cerioporidae*, but this is equally inadmissible. I have already called attention‡ to the probability that the British Carboniferous Polyzoon named *Ceriopora interporosa*, Phill., and *C. similis*, Phill., were referable to *Rhombopora*, and I am glad to find that Mr. Ulrich confirms my opinion as regards the former after an examination of its microscopic structure.

*Genus—RHOMBOPORA, Meek, 1872.*

(Hayden's Report E. Nebraska, p. 141).

*RHOMBOPORA LAXA, Etheridge, sp., Pl. 9, figs. 8 and 9.*

*Ceriopora ? laxa*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., Pt. 3, p. 332, t. 25, f. 2 and 2a.

*Rhombopora ? laxa*, Etheridge fil., Cat. Australian Foss., 1878, p. 46.

*Sp. Char.* Polyzoarium loosely dendroid; branches sub-cylindrical or compressed, bifurcating twice or thrice; cell-apertures small, equal, apparently round, and opening obliquely upwards and outwards, arranged in quincunx. Spiniform tubuli not observed.

*Obs.* Mr. R. Etheridge, F.R.S., who described this species, states that it possessed affinity with *Rhombopora serialis*, Portlock,§ from the Carboniferous rocks of Hook Point, Wexford, although the cell-apertures are neither so densely nor so regularly arranged as in that species. My Colleague has obtained what may be considered a large variety of this species, differing, however, in no other particular than that of size from the original specimens. *R. laxa* has hitherto been met with only as natural sections, and the surface characters are in consequence unknown.

*Loc. and Horizon.* Gympie (*The late R. Daintree and R. L. Jack*); Rhynchonella Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

The Polyzoa in the green chloritic rock of Gympie are seldom recognisable, but are usually preserved merely as black or very dark, apparently carbonaceous, stains, and are therefore more than ordinarily difficult to determine. In addition to *Protorettepora ampla*, there is a form with a strong resemblance to *Retepora ? laxa*, De Koninck,|| in its irregularity of growth, but it may perhaps be only a *Protorettepora* rendered rough and irregular by the hackly fracture of the stone. A third form, either *Fenestella* or *Polypora*, of a stiff and rigid appearance, possessing very large, square, oblong fenestrules, appears to be a characteristic species. The interstices are straight and regular, and the dissepiments at right angles (Pl. 8, fig. 9).

\* Hist. Brit. Marine Polyzoa, 1880, p. 577.

† Handb. Pal. Bd., i., p. 609.

‡ Ann. and Mag. Nat. Hist., 1887, xx., p. 30.

§ Report Geol. Londonderry, Tyrone, &c., 1843, p. 327, t. 22a, f. 6.

|| Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, t. 8, f. 6 (See Pl. 8, figs. 10 and 11.)

Genus—*MYRIOLITHES*, Eichwald, 1860.

(Lethæa Rossica, 1860, i., p. 450.)

*MYRIOLITHES*? *QUEENSLANDENSIS*, *sp. nov.*

*Sp. Char.* Polyzooarium small, with the branches oval, or more or less flattened. Cells very small, round, arranged in vertical series, alternate or sub-alternate, their margins rim-like or a little exsert, and somewhat more than their own diameter apart; intercellular surface vermicular striate, the striæ anastomosing above and below each cell-aperture, or they are at times sub-parallel to one another.

*Obs.* This little fossil, which occurs in fragments on the surface of weathered limestone, has given me much trouble, but accords better with Eichwald's description of *Myriolithes* than with any other similar genus with which I am acquainted. I have, however, failed to detect any intermediate capillary tubes. It is allied to *M. monticola*, Eichwald, from Carboniferous Limestone of the Oural, but differs in its method of branching, and in the form and arrangement of the cells. I have not yet examined sufficient material to warrant my assigning it to any particular family.

*Loc. and Horizon.* Blenavon, Lilymere, near Rockhampton (*The late James Smith*); Lilymere Marble—Gympie Beds.\*

Section—*MOLLUSCA VERA.*Class—*BRACHIOPODA.*Order—*TRETENTERATA.*Family—*TEREBRATULIDÆ.*Genus—*DIELASMA*, King, 1850.

(Mon. Perm. Foss. England, p. 146.)

*DIELASMA CYMBÆFORMIS*, *Morris*, Pl. 9, figs. 10 and 11.

*Terebratula cymbæformis*, *Morris* in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 278, t. 17, ff. 4 and 5.

„ *biundata*, *McCoy*, Ann. and Mag. Nat. Hist., 1847, xx., p. 231, t. 13, f. 9.

„ *sacculus*, var. *hastata* (pars) *Etheridge* fil., Cat. Australian Foss., 1878, p. 61.

„ *sacculus*, var. *cymbæformis*, *De Koninck*, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 255, t. 15, f. 4 and 4a.

*Obs.* On the publication of the "Catalogue of Australian Fossils," I, in common with others, believed this to be only a form of the ordinary *D. sacculus*, so characteristic of Carboniferous rocks, but the acquisition of other specimens now leads me to a contrary opinion. The shell generally is more attenuated and higher towards the umbonal region of the ventral valve, much more overcurved, and the shoulders longer and more pronounced. The foramen is vastly larger in comparison with the size of the shell, much more truncate and horizontally placed. The dorsal valve is arched in a greater degree, becoming in some examples sub-angular towards the umbo. Lastly, the lateral margins of the united valves are always more sinuated. For the reason now stated, I believe *D. hastata*, Sby., and *D. cymbæformis* should be retained as separate species. With the exception of the unusually large specimen of *D. hastata* figured by

\* Also reported by Mr. Smith, from the Limestones at Dalma (Rockhampton District) and Raglan (Port Curtis District), but I much question its occurrence at the latter locality. (*R. E. Junr.*)

the late Dr. T. Davidson,\* this shell is probably one of the largest of the Upper Palæozoic Terebratulæ known. The British specimen measures two and three-quarter inches in length, two inches in breadth, and one and a-half in depth. The present shell, on the contrary, is two and a-half inches long, and two inches in breadth, but the depth is reduced to a quarter of an inch. In the high shoulders of the ventral valve, and size and position of the foramen, there is a strong resemblance to *D. elongata*, Dana.† But the lateral margins in this species are much curved concavely, not sigmoidally, and the front margin was probably entire. The curvature of the shell in the present species is well displayed both in Morris's and De Koninck's figures, whilst in the former are also shown the impressions of the strong dental plates, equally well seen in our specimen. The form of the foramen is likewise well preserved, even to the entire margin.

*Loc. and Horizon.* Mouth of Coral Creek, Bowen River Coal Field (*E. Edelfelt*)—Middle or Marine Series of the Bowen River Coal Field.

*DIELASMA SACCULUS, Martin, var.*

*Conch. (Anomites) sacculus*, Martin, Pet. Derh., 1809, p. 14, t. 46, f. 1 and 2.

*Terebratula sacculus*, Davidson, Mon. Brit. Carb. Brach., 1857, Pt. 1, p. 14, t. 1, f. 23, 24, 27, 29, 30.

*Dielasma sacculus*, De Koninck, Faune Calc. Carb. Belgique, 1887, Pt. 6, p. 27, t. 6, ff. 14-17, 19-26, 35-45, t. 7, f. 60-77.

*Sp. Char.* Shell obovate, depressed, concavo-convex, especially towards the front, which is not sinuated. Ventral valve depressed, convex, becoming flat and narrowed towards the front. Dorsal valve convex immediately below the umbone, becomes flattened, and then concave as the front is approached. Length, two inches and three-quarters; breadth, one inch and three-quarters.

*Obs.* The depressed boat-shaped outline, and its extreme shallowness as compared with its length and breadth, are very marked features in this shell. The surface of the ventral valve carries a few indistinct concentric furrows. The lateral marginal curve of the valves is very slight. In outline we here have a distinct resemblance to the little variety termed by Davidson *gillengensis*,‡ but the great difference in size will at once distinguish our shell.

*Loc. and Horizon.* Banana Creek, near Banana, Dawson River (*H. Mackay*; Colln. De Vis)—Middle or Marine Series of the Bowen River Coal Field.

*DIELASMA SACCULUS, var. HASTATA, J. de C. Sowerby.*

*Terebratula hastata*, J. de C. Sby., Min. Con., 1824, v., p. 66, t. 446.

„ „ Davidson, Mon. Brit. Carb. Brach., 1857, Pt. 1, p. 11, t. 1, ff. 1-12.

„ *sacculus*, var. *hastata*, De Koninck, Rech. Foss. Pal. Nouv.-Galles du Sud, 1877, Pt 3, p. 257, t. 15, ff. 3 a-f.

*Dielasma hastatum*, De Koninck, Faune Calc. Carb. Belgique, 1887, Pt. 6, p. 9, t. 3, ff. 1-26, etc.

*Obs.* A single small and worn, but almost complete example of this variety of the above protean species has been met with. There seems to be little or no sinuosity in the front margin, the ventral valve is very much flattened, and the dorsal valve more arched. Beyond the general outline there are no characters which can be seized upon for description.

*Loc. and Horizon.* Rockhampton District § (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

\* Mon. Brit. Carb. Brach., 1880, iv., Pt. 3, t. 30, f. 17a and b.

† Geology Wilkes' U. S. Explor. Exped., 1849, x., Atlas, t. 1, f. 3a.

‡ Davidson, *loc. cit.*, p. 17, t. 1, figs. 18-20.

§ See note, p. 199.



DIELASMA, ? *sp. ind.*, Pl. 40, figs. 1 and 2.

*Obs.* This very remarkable form resembles an unnamed shell figured by Dana \* in the general form and proportion of its valves. The shell is long-oval, with much compressed valves, the ventral very slightly convex, the dorsal nearly flat immediately below the umbone, becoming more or less concave towards the front; the valve margins are not in any way sinuous, but simply gradually curved.

It certainly cannot be referred to *D. cymbæformis*, but corresponds, so far as mere outline is concerned, with *D. gillengensis*, Davidson, † but the difference in size is remarkable, and the valves of the present Brachiopod are narrower forwards. Another of Dana's species, *D. amygdala*, ‡ although again smaller in size, has a very depressed dorsal valve, and is to some extent like it.

It is even questionable whether it be correctly referred to *Dielasma*, as the surface of the ventral valve shows signs of a long septum. It is a very puzzling form, and would appear to resemble some of the Devonian Terebratulidæ rather than those of higher Palæozoic rocks.

*Loc. and Horizon.* Rockhampton District § (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

## Family—SPIRIFERIDÆ.

*Genus*—SPIRIFERA, *J. Sowerby*, 1816.

(Min. Con., ii., p. 41.)

*Obs.* No more difficult group exists in the Australian Permo-Carboniferous Series than the Spirifers. So many species have been made on fragments, and the presence of European species so frequently determined on indifferent specimens, that it has become almost impossible to establish with certainty what species do exist. I hope, however, to unravel this confusion when the study of the large series of New South Wales specimens is undertaken. In the meantime the following determinations must be accepted as a temporary solution of the Queensland species, although I am anything but satisfied with it.

SPIRIFERA STRIATA, *Martin*, sp., ? Pl. 9, fig. 16.

*Spirifera striata* (Martin), Davidson, Mon. Brit. Carb. Brach., 1857, Pt. 1, pp. 19 and 246, t. 2, ff. 12-21.

„ „ Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 334, t. 17, f. 5.

*Obs.* The mesial fold is not so well defined as in the typical *S. striata*, and some transverse forms of *S. bisulcata* assume this shape. We may, however, confidently refer it to the above shell, or one of its many varieties.

This most variable and widely distributed species of the genus *Spirifera* appears to be not uncommon, as I have been given to understand that individuals of the species are abundant in the Bowen River Series. (*Etheridge*.)

Without for a moment venturing to deny that this may be *Spirifera striata*, it at the same time appears exceedingly doubtful. The ribs are much too few in number, do not possess the angular sharp outline of *S. striata*, and the sulcus seems to be quite plain. The specimen was evidently a very imperfect one, and the cardinal angles may have been either acute or rounded. It is, in fact, impossible to say what

\* Geology Wilkes' U. S. Explor. Exped., Atlas, t. 1, f. 4d.

† Mon. Brit. Carb. Brach., 1857, Pt. 1, t. 1, f. 18-20.

‡ Dana, *loc. cit.*, t. 1, f. 2d.

§ See note, p. 199

the species was. For my own part, I cannot say that a *Spirifera* which could be definitely referred to the present species has ever come under my notice from Queensland rocks.

*Loc. and Horizon.* "Bowen River, Peak Downs" \* (*The late R. Daintree*)—Middle or Marine Series of the Bowen River Coal Field.

*SPIRIFERA, sp. ind. (a.), Pl. 9, fig. 12.*

*Spirifera*, allied to *S. striata*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 336, t. 18, f. 8.

(Compare *Spirifera yuennamensis*, De Koninck in Dumont D'Urville, Voy. au. Pole Sud, Géologie, Atlas, 1846, t. 9, f. 19-21.)

*Sp. Char.* Cardinal margin of dorsal valve long and straight; area moderately large; alar angles rounded; fold wide and prominent, but not angular, rounded and plain, expanding rapidly towards the front, bounded on each side by a marked depression or groove. From twelve to fifteen simple, flattened, curved ribs ornament the lateral portions of the valve, and are crossed by laminae of growth, which are also conspicuous on the fold.

*Obs.* This shell is only known to me in the condition of decorticated casts of the dorsal valve, averaging in size from one to one and a-quarter inches long. The chief points of interest are the plain fold, and the simple, flattened riblets. It is a very interesting species, which I have, so far, been unable to determine, but the general appearance of the specimens is well conveyed by the figure given by Mr. Etheridge, as above quoted. I have described the fold as plain, but on two of the specimens before me there is a faint division perceptible, in others its surface is quite unbroken; no great amount of convexity could have existed in this valve. The published figure does not convey to me the idea of *Spirifera striata* at all, nor do I think it can be so referred, the riblets being much too wide for the size of the valve.

The figure of De Koninck's *S. yuennamensis*, published by D'Orbigny, closely resembles the specimens from Rockhampton, only the former is much larger, and the ribs are less in number, only nine on each side; the comparison is, however, worth entertaining. The sulcus on each side the fold is a marked feature, and should assist in identification.

*Loc. and Horizon.* Don River (*The late R. Daintree*)—Gympie Beds; Rockhampton District † (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

*SPIRIFERA VESPERTILIO, G. B. Sowerby, Pl. 10, fig. 8.*

*Spirifera vespertilio*, G. B. Sowerby in Darwin's Geol. Obs. Volc. Islands, 1844, p. 160.

" " Morris in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 282, t. 17, f. 1 and 2  
(? excl. f. 3.)

" " Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 329, t. 16, f. 2.

*Obs.* Ill-preserved *Spiriferæ*, probably referable to this species, have been met with at two localities. Respecting the specimen figured by Mr. Etheridge, he says—"It has not the number of ribs described by Sowerby; but their angular, imbricated, or fimbriated condition, the width of the mesial fold or ridge, and the pointed beak, with the transversely fusiform shape of the one valve, are sufficient to warrant my retaining this name for the specimen from Gympie." He adds—"Five or six rows of acutely angular imbrications are distinguishable upon the mesial fold, and traceable along the attenuated lateral wings of the cardinal angles."

\* Probably "Bowen River" is correct. The Bowen River is not included in the Peak Downs District. (*R.L.J.*)

† See note, p. 199.

In addition to the above, the late Mr. James Smith has obtained, at Stanwell, a small *Spirifera*, possessing a lengthened hinge-line, flattened wings, an angular dorsal fold, and sharp ribs visible near the front margin. Such characters would indicate it to be a young form of *S. vespertilio*.

*Loc. and Horizon.* Gympie (*The late R. Daintree*); Stony Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

#### SPIRIFERA CONVOLUTA, *Phillips*, Pl. 10, figs. 10 and 11.

*Spirifera convoluta*, *Phill.*, Ill. Geol. York, 1836, ii., p. 217, t. 9, f. 7.

" " Davidson, Mon. Brit. Carb. Brach., 1857, Pt. 1, p. 35, t. 5, f. 2-15 (*for general synonymy*).

" " ? Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 335, t. 17, f. 3.

" " Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 280, t. 7, f. 6.

*Obs.* The most satisfactory example of this species yet obtained in Queensland has been figured by Mr. R. Etheridge, F.R.S., who remarked on it—"We may refer this fragment to *Sp. convoluta*, its extreme width and straight hinge-line essentially ally it to this shell; the acute angles at the extremities are lost, still many of our Yorkshire shells strongly resemble this species; the ribs on the mesial fold are also less defined than on most typical forms."

*Loc. and Horizon.* Bowen River (*The late R. Daintree*); Parrot Creek, four and a quarter miles up Bowen River (*R. L. Jack*)—Middle or Marine Series of the Bowen River Coal Field.

#### SPIRIFERA LATA, *McCoy*.

*Spirifera lata*, *McCoy*, Ann. and Mag. Nat. Hist., 1847, xx., p. 233, t. 13, f. 7.

*Spirifer latus*, *De Koninck*, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 244.

*Obs.* It is with considerable hesitation that I introduce this as a Queensland species. I have not yet seen a specimen either from this Colony or from New South Wales possessing smooth alar expansions in connection with as large a number of ribs as described by *McCoy*. On the other hand, here are several in which the wings are certainly devoid of costæ, and the bodies of the shells bearing nine instead of from sixteen to eighteen. The cardinal margin is long with acute angles, and the lateral portions of the valves spreading and wing-like. The fold is very prominent, high towards the front, and appears to have been divided by a narrow groove. The sinus furrows the ventral umbone quite from its apex, gradually spreading out towards the front, where it is wide and moderately deep. Particularly well-marked growth-laminæ crossed the valves longitudinally.

The wings are not devoid of ribs to the same extent as *McCoy*'s representation of *S. lata*, but still sufficiently so to become a point of importance in the determination of the species. The plain fold and sinus at once separate these shells from *Spirifera vespertilio*, whilst the simple costæ are equally important in distinguishing them from *S. convoluta*.

*Loc. and Horizon.* Yatton Gold Field (*R. L. Jack*)—Gympie Beds; Banana Creek, near Banana (*D. Mackay*; Colln. De Vis)—Middle or Marine Series of the Bowen River Coal Field.

#### SPIRIFERA CLARKEI, *De Koninck*, Pl. 10, fig. 16.?

*Spirifer Clarkei*, *De Koninck*, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 236, t. 13, ff. 2, 2a.

*Obs.* Our knowledge of this good species, as a Queensland shell, depends upon a decorticated specimen which I cannot otherwise refer. The sinus of the ventral valve is quite devoid of ribs, but possesses from twelve to thirteen simple ones on each

flank; the umbo is prominent and sharp. The fold of the dorsal valve is proportionately narrower than in De Koninck's illustration, and there are faint indications of slight ribs, but these are the only points in which our specimen differs from *S. Clarkei*. Both valves bear traces of strong concentric laminae.

*Loc. and Horizon.* Stonehumpy Creek, Bowen River (*E. Edelfelt*)—Middle or Marine Series of the Bowen River Coal Field.

SPIRIFERA TRIGONALIS, *Martin*, sp.

SPIRIFERA TRIGONALIS, *var. BISULCATA*, *J. de C. Sowerby*, Pl. 9, fig. 15.

*Spirifera bisulcata*, J. de C. Sby., Min. Con., 1825, v., p. 152, t. 494, ff. 1, 2.

„ *trigonalis*, *var. bisulcata*, Davidson, Mon. Brit. Carb. Brach., 1857, Pt. 1, p. 31, t. 5, f. 1, t. 6, f. 1-19, t. 7, f. 4; *Ibid.*, 1862, Pt. 5, p. 222.

„ *allied to S. bisulcata*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 335, t. 17, f. 4.

*Spirifer bisulcatus*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 246, t. 14, f. 5.

*Obs.* Both in the Permo-Carboniferous rocks of New South Wales and Queensland, a *Spirifera* occurs, sometimes acquiring considerable dimensions, and possessing many of the characters of the common *S. bisulcata*. The costæ in this species are very characteristic, and are either flat or flatly rounded, close to one another, and frequently bisulcate. Both the fold and sinus are similarly occupied. The costæ and intercostal spaces are minutely and longitudinally striate, and, when in a good state of preservation, very minute and very wavy. Similar lines can be detected accompanying the lines of growth in a transverse direction. This is a marked feature in *S. bisulcata*, and equally so in the Queensland shells. The latter appear to me to be less convex and gibbous than the present variety of Martin's shell, and in some points almost to agree better with the *var. crassa*, De Koninck. Although the tendency of the ribs to arrange themselves in three groups on the fold is not to any great extent marked, it is still apparent. In two of our specimens the long reniform vascular impressions are well displayed, and as I do not remember to have seen an illustration of this anatomical point in *S. bisulcata*, a figure of it is given.

*Loc. and Horizon.* Bowen River (*The late R. Daintree*)—Middle or Marine Series of the Bowen River Coal Field; Rockhampton District \* (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

SPIRIFERA TRIGONALIS, ? *var. ACUTA*, *Etheridge*, Pl. 10, fig. 12.

*Spirifera bisulcata*, *var. acuta*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 329, t. 16, f. 1.

*Obs.* The varietal name *acuta* was applied by Mr. R. Etheridge, F.R.S., to a shell which appears to differ from ordinary forms of *S. trigonalis* and its varieties, in its much fewer and simpler ribs, and grooved fold. I am not prepared to offer any suggestion as to its identity other than the above.

*Loc. and Horizon.* Gympie (*The late R. Daintree*)—Gympie Beds.

SPIRIFERA TRIGONALIS, *var. CRASSA*, *De Koninck*, Pl. 11, fig. 5.

*Spirifer crassus*, De Koninck, Rech. Anim. Foss. Terr. Carb. Belgique, 1843, p. 262, t. 15 bis, f. 5.

*Spirifera crassa*, Davidson, Mon. Brit. Carb., Brach., 1857, Pt. 1, p. 25, t. 6, f. 20-22, t. 7, f. 1-3.

„ *trigonalis*, *var. crassa*, Davidson, *loc. cit.*, 1862, Pt. 5, p. 222.

*Obs.* We have before us (Pl. 11, fig. 5) a portion of a large decorticated *Spirifera*, resembling in general outline and appearance *Martiniopsis subradiata*, Morris, but with the exterior bearing the almost flattened "rounded, unequal, bifurcated, or

\* See note, p. 199.

intercalated ribs" both on the fold and sinus of De Koninck's shell, as described by Davidson; and not "with a few undefined, and numerous faintly elevated ridges more visible in the cast," as seen in the former and Australian species. *M. subradiata* at times assumes very large proportions and possesses, on the cast, many indistinct, simple, radiating ridges, and notwithstanding the unequal bifurcating nature of those on *S. crassa*, it is, of course, just possible that we may be dealing only with an extreme variety of our common form, although I am much more inclined to take the other view. Neither do I believe that it is in any way related to the shell figured by Professor De Koninck as *Spirifera pinguis*, var. *rotundata*,\* in which the ribbing is broad, more or less equal, with but little interpolation, whilst the fold and sinus are comparatively devoid of ribs.

*Loc. and Horizon.* Stony Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

SPIRIFERA DUBIA, *Etheridge*, Pl. 10, fig. 14.

*Spirifera dubia*, *Etheridge*, Quart. Journ. Geol. Soc., 1872, xxviii., p. 330, t. 16, f. 6.

*Sp. Char.* Shell transversely semi-circular; hinge-line nearly as long as the width of the shell; cardinal angles gently rounded; mesial fold having many small ribs, and wide at ventral border of shell; eight or nine ribs occur on each side of the mesial fold upon the cardinal angle or lateral portion of the shell, and some of the ribs upon the lateral areas bifurcated as they approached the ventral margin. (*Etheridge*.)

*Obs.* This shell resembles some forms of *Spirifera undulata*,\* but the ribs are finer than in normal forms of that species; the ribbed mesial fold and bifurcating lateral ribs are essential points of difference. Not having any outer shell, we have no means of determining any markings upon the valves; but it differs from known species of *Spirifera*. I know of no species, either Devonian or Carboniferous, to which the above shell can be referred, the rounded cardinal angles and almost semi-circular dorsal valve distinguishing it from every known form. (*Etheridge*.)

*Loc. and Horizon.* Gympie (*The late R. Daintree*)—Gympie Beds.

SPIRIFERA, *sp. ind. (b.)*, Pl. 38, figs. 4-6.

*Spirifer vespertilio*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, t. 13, f. 4b and c (excl. f. 4a and b); t. 14, f. 3?—(non G. B. Sowerby).

*Sp. Char.* Shell oblong-triangular; valves unequally convex; cardinal margin almost as long as the valves, but the alar angles rounded; front margin laterally in one plane, much sinuated in the middle line. Ventral valve convex, with a well-defined deep sinus extending some distance forward; shoulders high; umbo elevated and probably a good deal incurved; area wide and barely as long as the cardinal margin; fissure large and triangular; cardinal muscular impressions broadly lingual; adductor scars very narrow; shelly plates large and thick. Dorsal valve with the flanks only slightly convex; fold prominent, high, and wall-sided, umbo depressed. Ventral valve bears six prominent, simple, straight, and somewhat unequal ribs, with a few indistinct and flattened ribs in the sinus; fold plain, the flanks of the dorsal valve bearing the same number of costæ; interspaces plain and wider than the latter.

*Obs.* The above characters are taken from well-preserved casts. They agree most satisfactorily, and are probably identical with the short smaller form figured by De Koninck as *Spirifera vespertilio* (*loc. cit.*, t. 13, f. 4b and c). It is, however, doubtful if these are G. B. Sowerby's species of that name as figured by Morris. In the former's

\* Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, t. 14, f. 2.

original description it is said, "breadth more than double its length." Morris describes *S. vespertilio* as "transversely fusiform"; but, in his illustrations, Morris himself has, I believe, figured two distinct species under Sowerby's name. His figures 1 and 2 (Pl. 17),\* are *S. vespertilio*, whilst fig. 3 of the same plate is another form, much shorter, less triangular, and much too high a shell. Professor De Koninck, wholly ignoring Morris's description, adopts the extraordinary method of applying the name to the aberrant fig. 3. His *S. vespertilio* is, therefore, to some extent not the species intended by the earlier writers named, but is distinct, and agrees with the casts above described from Queensland. If the latter, and the figures cited in De Koninck's work are in want of a name, I would propose to call them *Spirifera Stutchburii*, after the late Mr. Samuel Stutchbury, the first Government Geologist of New South Wales, and at a time when that Colony and Queensland formed one territory. The true *S. vespertilio* is a long-winged, very alate shell, and quite distinct from the short triangular deltoid forms now under consideration.

*Loc. and Horizon.* Richards' Homestead, three miles south-west of Mount Britton Township, Lat. S. 21° 20', Long. E. 148° 30' (*A. L. Morisset*)—Middle or Marine Series of the Bowen River Coal Field.

#### SPIRIFERA TASMANIENSIS, *Morris*, Pl. 10, fig. 1, and ?15.

*Spirifera rotundata*, G. B. Sowerby in Darwin's Geol. Obs. Volc. Islands, 1844, p. 159 (*non Phillips*).

*Spirifer Tasmaniensis*, Morris in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 280, t. 15, f. 3 and 4.

*Spirifer Tasmaniensis*, De Koninck, Foss. Pal. Nouv.-Gallies du Sud, 1877, Pt. 3, p. 248, t. 9, f. 7.

„ *Tasmanni* (sic), Von Buch, Abhandl. K. Akad. Wissen. Berlin, 1846 [1848], p. 75, f. 3a and b.

*Obs.* We possess a decorticated example, which, from its shape and general appearance, seems to be this species. It is from the Bowen River Series. But, like De Koninck's figure, more ribs are present than laid down in Morris's description. Probably ten, as stated by Morris, may be regarded as the lowest number, graduating up to fifteen or twenty, by counting all the bifurcations.

Another specimen possessing prominent angular ribs, united into indefinite bundles of three, may also be *S. tasmaniensis* (Pl. 10, fig. 15). It is possible that this species will prove to be only a variety of the much better marked *Spirifera Stokesii*. Amongst extra-Australian species, compare *S. musebachanus*, F. Roemer,† from Texas, which is very closely allied, having the same shape, clustered ribs, and highly decussated appearance.

*Loc. and Horizon.* Stonehumpy Creek, Bowen River (*E. Edelfelt*); Banana Creek, near Banana, Dawson River (*The late James Smith*)—Middle or Marine Series Bowen River Coal Field.

#### SPIRIFERA STOKESII, *König*, sp., Pl. 10, figs. 2-4.

*Trigonotreta Stokesii*, König, Icones Foss. Sect., 1825, p. 3, t. 6, f. 70.

*Spirifera trapezoidalis*, G. B. Sowerby in Darwin's Geol. Obs. Volc. Islands, 1844, p. 159.

*Spirifer Stokesii*, Morris in Strzelecki's Phys. Descrip. N. S. Wales, 1845, p. 283, t. 15, ff. 1, 1a.

„ *Stokesii* (sic), Von Buch, Abhandl. K. Akad. Wissen. Berlin, 1846 [1848], p. 76.

„ *Stokesii*, D'Orbigny in Dumont D'Urville's Voy. au Pôle Sud, Géologie, Atlas, 1846, t. 9, ff. 12-14.

*Sp. Char.* Shell subtetragonal to trapezoidal, or deltoid, rough-looking, globose, at times sub-alate, but the valves unequally convex, and the front deeply sinuate. Ventral valve convex, more so than the dorsal, much produced in front, high in the umbonal region; sinus broad and deep, extending well on to the umbo, which is prominent and much incurved; area well marked, as long as the valve, wide; alar angles rounded as a rule, occasionally bluntly pointed, on the inner surface of valve

\* Strzelecki's Phys. Descrip. N. S. Wales, 1845, &c.

† Kreidebild. Texas, 1852, p. 88, t. 11, f. 7a-c.

much grooved and ridged; shelly plates large, strong, and thick; dental plates large, extending outwards and downwards; adductor scars comparatively small, much elongated; cardinal impressions large, elongate, festoonly ridged. Dorsal valve angularly convex, much produced along the middle line of the fold, which is sharp and angular; umbo projecting above the area. Ornament of the valves very characteristic, the flanks in both bearing four or five rough-looking costæ, each composed of two to five subsidiary ribs, the bifurcation taking place at about one-third from the umbones; the fold bears three slightly elevated costæ on each side, and the sinus is similarly divided, the whole being crossed by concentric distant, wavy, and strong imbricating lamellæ of growth.

*Obs.* The size, form, and coarse ornament are the chief points worthy of notice in *S. Stokesii*. The interspaces between the groups of costæ, sometimes, although rarely, carry smaller and subsidiary ribs. The wings are traversed by flattened, close ribs, similar to the latter, but they do not project like those on the bodies of the valves. On the ventral valve the costæ appear at times to be less split up than those of the dorsal, until contiguous to the front margin. Prof. Morris's description is very characteristic of the species. He says—"A rough-looking species in consequence of the paucity and size of the lateral ribs, the central one being still prominent."

*Spirifera Stokesii* is probably the largest of the Australian radiate Spirifers, and belongs to the same group as *Spirifera dupplicicosta*, Phill.,\* of the European Carboniferous, and which possesses similar tripartite costæ. The best figure of this species with which I am acquainted is D'Orbigny's. In this illustration there are three large divided ribs on each flank, and the interspaces filled as previously described. The fold has three ribs on each side.

*Spirifera Keilhavii*, Von Buch, has coarse angular ribs like our species, but the form of the shell is quite different.

*Loc. and Horizon.* Gympie—Gympie Beds; Banana Creek, near Banana, Dawson River—Middle or Marine Series of the Bowen River Coal Field; Yatton Gold Field (*R. L. Jack*)—Gympie Beds; Richards' Homestead, three miles south-west of Mount Britton Township (*Messrs. A. L. Morisset and R. Hull*)—Middle or Marine Series of the Bowen River Coal Field.

#### SPIRIFERA PINGUIS, *J. Sowerby*.

*Spirifer pinguis*, *J. Sowerby*, *Min. Con.*, 1820, iii., p. 125, t. 271.

*Spirifera pinguis*, *Davidson*, *Mon. Brit. Carb. Brach.*, 1858, Pt. 2, p. 50, t. 10, f. 1-12.

*Spirifer pinguis*, var. *rotundatus*, *De Koninck*, *Foss. Pal. Nouv.-Galles du Sud*, 1877, Pt. 3, p. 238, t. 14, f. 2, 2a.

*Obs.* Numerous examples of a rather small species occur in the altered rocks of the Rockhampton District, none actually perfect, but, as far as preserved, closely resembling some of Davidson's figures of the above species, particularly his figs. 1-3. The ribs are rounded, one or two indistinct ones occupying the sinus, whilst the fold is plain. Over and above this, the specimens, although imperfect, have that indescribably rotund and rotundly-radiate appearance which always accompanies this species. Davidson remarks on *Spirifera pinguis*—"Very variable in shape, dimensions, relative proportions, and degree of convexity," and the present shells may well come within this category.

*Loc. and Horizon.* Rockhampton District † (*C. W. De Vis*; Colln. *De Vis*)—Gympie Beds.

\* See Davidson's *Mon. Brit. Carb. Brach.*, 1857, Pt. i, t. 4, f. 4.

† See note, p. 199.

SPIRIFERA BICARINATA, *sp. nov.*

Pl. 10, figs. 9 and 13; Pl. 11, figs. 1 and 3; Pl. 37, fig. 17.

*Sp. Char.* Shell small, elongately triangular, very alate, and laterally extended. Hinge-line much extended, straight, greater than the general width of shell. Wings sharp, flattened, and narrowly triangular, with the alar angles pointed. Ventral valve convex, inflated centrally, flattened at the sides. Sinus moderately broad and deep, angular, bounded by prominent carina, without ribs. Umbo high, overhanging the hinge-line. Area very fine and narrow. Fold of the dorsal valve plain, and defined by deep sulci, corresponding to the carinæ of the ventral valve. Surface bears numerous, regular, fine costæ, usually simple and not often bifurcating, the interspaces bearing very delicate microscopic striæ, the whole crossed by occasional laminæ of growth.

*Obs.* The characters of this little shell appear to be very constant, the extended hinge-line, plain sulcus bounded by sharp carinæ, sharp alar angles, and the divided-off fold in the dorsal valve, all render it a conspicuous and well-marked form. I am unable to refer it to any known Australian species, whilst it possesses a considerable distribution, and strongly recalls some Devonian forms. Its nearest ally seems to be *Spirifera albapinensis*, H. & W.,\* from the Waverly Group of North America.

*Loc. and Horizon.* Corner Creek, Great Star River (*R. L. Jack*); Gully between two peaks on the left bank of the Keelbottom River, north of Old Plum-tree Inn (*R. L. Jack*)—Star Beds; Hawkins' Gully, Kariboe Creek, Kroombit Diggings, Port Curtis (*W. H. Rands*); and ? Stony Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

SPIRIFERA STRZELECKII, *De Koninck*, Pl. 10, figs. 5-7.

*Spirifera undifera*, var. *undulata*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., pp. 330 and 331, t. 15, f. 4, t. 16, f. 3-5.

*Spirifer Strzeleckii*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 235, t. 13, f. 1, t. 14, f. 1.

*Obs.* A full description of this shell will be found in Prof. De Koninck's Memoir, but it may be incidentally mentioned in passing that his figures do not correspond in every respect with those of Mr. R. Etheridge, F.R.S., on which he established his species, but this may perhaps be owing to the usually indifferent state of preservation of the Gympie examples. The following observations are quoted from the original Paper:—"The Queensland specimens differ little amongst themselves, all having the well marked mesial fold in the ventral valve and eight or ten ribs on either side; the hinge-line is shorter than the width of the shell, and the cardinal angles are rounded. The beak in dorsal valve incurved; there are faint tracings of the concentric ridges or folds, but, owing to all the specimens being casts, the more delicate markings cannot be determined." (*Etheridge*.) In some points there is a close resemblance between *S. Strzeleckii* and *S. Darwinii*.

*Loc. and Horizon.* Lady Mary Reef, Gympie (*The late R. Daintree*); No. 6 North Phoenix Mine, Gympie (*S. Hester*)—Gympie Beds; ? Richards' Homestead, three miles south-west of Mount Britton Township (*R. Hull*)—Middle or Marine Series of the Bowen River Coal Field.

Genus—SPIRIFERINA, *D'Orbigny*, 1847.

(Comptes Rendus, xxv., p. 268.)

SPIRIFERINA DUODECIMCOSTATA, *McCoy*, Pl. 44, fig. 12.

*Spirifera duodecimcostata*, McCoy, Ann. and Mag. Nat. Hist., 1844, xx., p. 234, t. 17, f. 2 and 3.

*Spirifer duodecimcostata*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 234, t. 12, f. 4.

*Obs.* The perfectly neat oval form with a well-developed area, simple undivided, rounded, and coarse ribs, to the number of six on each flank, a divided fold, and a

\* U. S. Geol. Explor. 40th Parallel, 1877, iv., Pt. 2, p. 255, t. 4, f. 5-8.



simple plain sulcus, with the whole crossed by close flat frill-like imbrications, serve to easily distinguish this species. The ribs are divided from one another by their own width apart, but the rib, however, mentioned by McCoy as traversing the sulcus does not appear to be a constant character, for out of eleven specimens before me only two show it. It is a remarkably narrow species, as compared with its width, giving to the marginal outline a rotund or roundedly-triangular appearance. By a lucky coincidence I am happy to be able to show that this shell is referable to *Spiriferina* rather than to *Spirifera*. Both in a specimen from Mount Britton, and in another from a New South Wales locality, there is visible the deep central slit left in casts by the median ventral septum, which exists in *Spiriferina*, as well as the vertical shelly plates. In both examples, also, the punctate shell-structure so characteristic of this genus is quite apparent. The Queensland specimen is by no means perfect, and exhibits only four ribs on each flank. It is an internal cast of the ventral valve, and retains the punctate structure very distinctly.

*Loc. and Horizon.* Richards' Homestead, three miles south-west of Mount Britton Township (*A. L. Morisset*; Australian Museum Colln.)—Middle or Marine Series of the Bowen River Coal Field.

*SPIRIFERINA, sp. ind.*

*Obs.* A small shell occurs in the Star River Series having an entire mesial fold, and indications of numerous concentric, close-set, and frill-like lamellæ. Seven or eight pronounced ribs were seen on each side the fold, and traces of asperities representing punctate shell-structure. It is probably a small species of *Spiriferina*.

*Loc. and Horizon.* Corner Creek, Great Star River (*R. L. Jack*)—Star Beds.

*Genus—RETICULARIA, McCoy, 1844.*

(Synop. Carb. Limest. Foss. Ireland, p. 193.)

*RETICULARIA LINEATA, Martin, sp. ?*

*Conch. (Anomites) lineatus*, Martin, Pet. Derb., 1809, t. 36, f. 3.

*Reticularia lineata*, McCoy, Synop. Carb. Limest. Foss. Ireland, 1844, p. 193, t. 19, f. 15.

*Spirifera lineata*, Davidson, Mon. Brit. Carb. Brach., 1858, Pt. 2, p. 62.

*Reticularia lineata*, Davidson, Mon. Brit. Sil. Brach. Suppl., 1882, Pt. 1, p. 81.

„ „ Waagen, Pal. Ind. (Salt Range Foss.), 1883, Ser. xii., Vol. 1, No. 4, fasc. 2, p. 540, t. 42, f. 6-8.

*Obs.* This, the type species of McCoy's genus *Reticularia*, is represented in Mr. De Vis' Collection by a portion of a ventral valve only, but possessing the distinctly imbricated laminæ and numerous scars of the characteristic double spines. In the face of such features I cannot do less than refer the fragment to this species. A far better example of the ventral valve comes from the Rockhampton District,\* and well exhibits the points referred to. They will, at any rate, tend to show the existence of this group of the Spiriferidæ in the Permo-Carboniferous rocks of Queensland, a fact borne out by the species following.

*Loc. and Horizon.* Rockhampton District\* (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

*RETICULARIA UREI, Fleming, sp.*

*Spirifer Urei*, Fleming, Brit. Animals, 1828, p. 376.

*Spirifera Urei*, Davidson, Mon. Brit. Carb. Brach., 1858, Pt. 2, p. 58, t. 12, f. 13 and 14.

*Reticularia Urei*, Davidson, Mon. Brit. Sil. Brach. Suppl., 1882, Pt. i., p. 81.

*Obs.* Casts are met with in the Star River Beds which are difficult to distinguish from those of *Spirifera Urei*, and more especially the Devonian variety *unguiculus*,

\* See note, p. 199.

Phillips. In all the specimens the prominent and projecting umbone of the ventral valve is deeply channelled by a well-marked mesial sinus, which extends far up on the umbone. The latter was tolerably high, but did not overhang the area in any of the specimens. The deep sulcation of the ventral valve accords better with the Devonian than the Carboniferous variety of *Spirifera Urei*, and after a comparison with specimens from both formations, this has been found to be a constant and well-marked character.

*Loc. and Horizon.* Corner Creek, Great Star River (R. L. Jack)—Star Beds.

*Genus—MARTINIA, McCoy, 1844.*

*Martinia, McCoy, Synop. Carb. Limest. Foss. Ireland, 1844, p. 126.*

„ *Davidson, Mon. Brit. Carb. Brach., 1854, v., Pt. 3, p. 373.*

*MARTINIA ? PRODUCTOIDES, sp. nov., Pl. 11, figs. 6-11.*

*Sp. Char.* Shell elongately ovoid, narrow, more or less productiform in outline. Ventral valve elongate, narrow, moderately convex and curved, with a faint sinus in the umbonal region, more apparent in the young state; umbo well incurved over the area, which is short, wide, and somewhat concave, with a wide, deep, triangular fissure. Dorsal valve transversely ovoid, flatter and less arched than the ventral, umbo much less incurved, hinge-line longer in comparison to the width of the shell than in the ventral valve, area broad and concave, with a wide triangular fissure; fold divided by a groove or depression throughout its entire length. Surface of both valves apparently quite smooth. Internal cast of the ventral valve with several longitudinal ridges.

*Obs.* Although to some extent related to *Martinia glabra*, the elongated, produced, and narrow form, and short hinge-line are obviously so different from those characters in that species that I have not hesitated to propose the above name for the present shells, especially as the characters are constant throughout a large number of individuals. I believe them to be a very peculiar form of *Martinia*, possessing less the appearance of that genus, and more that of some *Producti*, or even abnormal, smooth *Pentameri*. The curvature of the shell is in itself peculiar, and when viewed from the front of the ventral valve has much the appearance of a *Productus*, but the presence of the well-developed area and fissure at once distinguishes these shells from the genus named.

I am undecided whether to regard the valve described above as the dorsal, as such, or as the young condition of the ventral valve. The occurrence of the two in common, and the size and shape of the smaller valves would favour the first view. On the other hand the area and fissure are too well developed to be those of a dorsal valve, and tend to support the latter opinion.

*Loc. and Horizon.* Township at Cania Diggings, Burnett; Three Moon Creek, three miles above Cania Diggings (W. H. Rands)—Gympie Beds. At the Training Wall Quarries, Rockhampton, and at Stony Creek, Stanwell [Gympie Beds], internal casts occur, which I believe to be those of this species (*The late James Smith*).

*Genus—MARTINIOPSIS, Waagen, 1883.*

(Pal. Indica (Salt Range Foss.), Ser. xiii., Vol. i., Pt. 4, fasc. 2, p. 524.)

*Obs.* Prof. J. D. Dana was the first who referred \* *Spirifer subradiatus*, G. B. Sowerby, to the characteristic European species, *Spirifera glabra*, Martin, a reference afterwards more fully carried out by Prof. De Koninck.† On the strength

\* Geology Wilkes' U. S. Explor. Exped., Vol. x., p. 683.

† Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 227.

of the united opinion of these distinguished Palæontologists, I so placed this species in my "Catalogue of Australian Fossils." A subsequent examination of good internal casts, however, of Morris's species, shook my belief in the advisability of this step, a belief still further strengthened on reading Dr. Waagen's description of his genus *Martiniopsis*.

If *Spirifer subradiatus*, which is, without doubt, one of the most characteristic shells of portions of our Permo-Carboniferous deposits, is rightly placed by Messrs. Dana and De Koninck, it naturally falls into *Martinia*, McCoy, a genus now universally adopted for shells after the type of *Spirifera glabra*, Martin.

Following Waagen, *Martinia* and his *Martiniopsis* are thus distinguished:—

Genus.	Area in d. valve.	Dental plates in v. valve.	Septal plates in d. valve.	Area in v. valve.	Shell Structure.
<i>Martinia</i> ... ..	...	absent ...	absent ...	large ...	moderately punctate.
<i>Martiniopsis</i> ... ..	present ...	present ...	present ...	small ...	punctate-fibrous.

"By the smoothness of the shell, and the general appearance, the forms belonging to this genus," says Waagen, when describing *Martiniopsis*, "appear to be very closely related to *Martinia*, and I was for a long time inclined to place these shells in that genus; but, after a careful study of typical specimens of *Martinia glabra* from Visé, which I owe to the kindness of Mons. De Koninck, I found that these shells were devoid of dental, as well as of septal plates, and were therefore distinct generically from the Indian fossils"—i.e., *Martiniopsis*.

Presuming on the accuracy of Waagen's discovery in the structure of *Martinia glabra*, it necessarily follows that we have two outwardly similar types of the non-costate Spirifers, possessing a widely different internal structure—*Martinia* and *Martiniopsis*.

Referring to Australian members of this family exhibiting this outward appearance, Waagen says—"In Australia the genus" (*Martiniopsis*) "appears to have attained a somewhat more extensive development. It seems at least probable that species like *Spir. Darwinii*, *Spir. oviformis*, and the large form figured by Mons. De Koninck under the name of *Spir. glaber*, belong to the present genus."

With the view of following out this suggestion, I have assembled a large number of internal casts of *Spirifera subradiata*, Morris, both from New South Wales and Queensland localities, and also *Spirifera Darwinii*, Morris (*non* De Koninck), and I find them to possess the leading characters of *Martiniopsis*, as laid down by Waagen, in all but one trivial feature. Taking *Spirifera subradiata* as the type, by reproducing from internal casts the aspect of the shelly plates in some yielding and suitable material, it will be found that very strong dental plates exist in the ventral valve. In casts these produce the deep depressions on each side the umbonal projection, and terminating, under the hinge-line, in the thick teeth. In the dorsal valve similar septal or crural plates produce like slits or depressions, and terminate under the hinge-line in sockets for the reception of the above teeth. It further becomes apparent, from a study of these internal casts, that the dorsal valve possessed a small area.

The presence of these shelly plates will at once remove *Spirifera subradiata* from the genus *Martinia* to *Martiniopsis*, under the name of *Martiniopsis subradiata*, Morris, sp., and it will cease to be a synonym of *Martinia glabra*, Martin, sp. The internal structure of this species was not lost sight of, to some extent, by De Koninck, but he failed to appreciate its importance.

According to Waagen the shell structure of both *Martinia* and *Martiniopsis* is punctate. In *M. subradiata* some of the shelly layers are certainly punctate, others equally fibrous. This is shown on one of Mr. De Vis' specimens, and I have seen a similar appearance on New South Wales examples. I should be inclined to regard it as punctate-fibrous; some portions of the shell are undoubtedly fibrous, this structure having been first noticed by Dana,\* whilst the punctate condition was equally elicited by De Koninck.

It must be distinctly understood that in thus adopting *Martiniopsis*, as separated from *Martinia*, I have relied solely on Waagen's description of the structure of the latter. I very much wished to obtain specimens of *Martinia glabra*, to examine the internal structure for myself, but circumstances have prevented this. However, the general accuracy of Dr. Waagen's observations emboldens me to place our Australian form provisionally in his genus, leaving to others who may have a plenitude of *Martinia glabra* to settle this question finally.

*Types.* *Martiniopsis inflata*, Waagen (Indian); *Martiniopsis subradiata*, Morris, sp. (Australian).

MARTINIOPSIS SUBRADIATA, G. B. Sowerby, sp., Pl. 11, fig. 14.

*Spirifera subradiata*, G. B. Sowerby, Darwin's Geol. Obs. Volc. Islands, 1844, p. 159.

*Spirifer subradiatus*, Morris, Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 281, t. 15, f. 5, t. 16, f. 1-4.

" *glaber*, Dana (non Martin), Geology Wilkes' U. S. Explor. Exped., 1849, Vol. x., p. 683, Atlas, t. 1, f. 6.

" " De Koninck (non Martin), Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 227 (excl. syn.), t. 11, f. 8 and 9, t. 12, f. 1a-c.

" *Darwini*, De Koninck (non Morris), *Ibid.*, p. 230 (excl. syn.), t. 10, f. 11a-b, t. 11, f. 10-10a, t. 16, f. 1.

*Spirifera glabra*, Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 280.

*Sp. Char.* Shell variable in shape and proportions, but usually transversely oval, at times becoming very transverse, and both valves much compressed; or short and oval, with the valves almost equally convex. Hinge-line less than the width of the shell, with the alar angles always rounded. Area of the ventral valve wide and irregular, but in the dorsal valve, narrow, and much longer. Ventral umbo either depressed and channelled, or to some extent elevated, and to all intents and purposes entire, usually overhanging the area. Sinus wide and plain, bounded by prominent obtuse folds; dorsal fold high and undivided, or broad, flattened, and divided by a median depression, and often bounded laterally by a groove on each side. Front margin in very convex forms much sinuated, but in compressed examples more in one plane. Teeth of the ventral valve large and thick; dental plates strong and long; cardinal muscular impressions long and oval, striated longitudinally and divided medianly by a double septum; ovarian impressions largely developed on the flanks. In the dorsal valve the septal plates are very long, frequently reaching half across the valve; adductor impressions elongately lingual, separated by a septum. Spiral arms highly developed, and nearly filling the interior of the shell. Cardinal process thick and large. The surface of the valves is smooth, with the exception of wide concentric laminæ of growth, but one or more obtuse radiating folds (as many as four) are sometimes present, according to the variety. On the surface of the cast, numerous indistinct, or half-effaced radiating, close ridges are faintly visible both on the flanks and dorsal fold, and in the sinus. Shell structure punctate and fibrous.

*Obs.* Since Dana first referred *Spirifera subradiata*, G. B. Sowerby, to Martin's *S. glabra*, it has been customary to unite with it a number of shells, all more or less

\* Geology Wilkes' U. S. Explor. Exped., loc. cit., p. 683.

resembling one another, but still differing to some extent in shape, and the exterior markings of the test. No doubt great resemblance exists externally between *S. glabra* and *Martiniopsis subradiata*, but, if Dr. Waagen's observations are to carry any weight, the likeness ceases here. I now purpose selecting a form to serve as the type of *M. subradiata*, and to consider the other conditions as well marked and recognisable varieties.

The true *M. subradiata*, as represented by Morris's figures, given in Count de Strzelecki's Work,\* is an elliptical, rather transverse, sub-compressed, comparatively smooth shell, possessing a wide shallow sinus, a low broad fold divided by a median ill-defined groove, and bounded on each side by a similar furrow, a high prominent ventral umbo, and long shoulders on either side. The flanks are either gently convex or flattened, with, now and then, undefined radiating costæ, crossed by distant concentric laminae of growth.

This species at times attains a considerable size, one specimen having come under my notice quite three and a-half inches in transverse diameter. Internal casts of the species proper usually display the slits left by the dental plates and processes of the ventral and the septal plates of the dorsal valve, the latter extending into the body of the shell for fully one-third of its depth. Such examples are met with in the Rockhampton District, especially at Banana Creek.

The structure of the test, to include this shell in *Martiniopsis*, should be punctate, and it is so described by De Koninck, who says—"Le têt est assez mince et perforé," the perforations being arranged in quincunx. In one of our Queensland specimens, preserved in limestone, a delicate pitting is observable on both flanks. The other portions are covered with a very fine striation or ribbing, visible to the naked eye. Wherever the surface is abraded this striation has the appearance of longitudinal tubes running through the substance of the test; but on those portions merely smoothed over by the denuding agent, these tubes appear as darker lines traversing the lighter coloured limestone of which the shell is composed.

The following may be taken as characteristic figures of *M. subradiata* :—

Morris in Strzelecki, *loc. cit.*, t. 16, f. 1-4.

De Koninck, *loc. cit.*, t. 12, f. 1.

Tab. nost., Pl. 11, fig. 14.

The varieties of this species known to me are, viz. :—

1. Var. *Morrisii* (mihl). See post.
2. „ *transversa* (mihl), De Koninck's Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, t. 12, f. 1b.
3. „ *Konincki* (mihl), De Koninck's Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, t. 10, f. 11 a and b, t. 11, f. 10 and 10a, t. 16, f. 1 (= *Spirifera Darwinii*, De Kon., non Morris).

In addition to these varieties, the two last of which I have not seen from Queensland, there is another form represented in Pl. 40, fig. 3. At first sight this would seem to be a variety of McCoy's *Spirifera oviformis*,† but it may be only a condition of *M. subradiata* on which a good deal of oblique lateral pressure has been exerted, and the ventral sulcus much pressed together.

*Martiniopsis subradiata* is quite distinct from both the Indian species, and its relation to *M. Darwinii* will be touched on under the description of the latter species.

*Loc. and Horizon.* Stonehumpy Creek, Bowen River (*R. L. Jack*); Banana Creek, near Banana, Dawson River (*H. Mackay*, Colln. De Vis; and the late *James Smith*); Richards' Homestead, three miles south-west of Mount Britton Township (*B. Hull*)—Middle or Marine Series of the Bowen River Coal Field; Gympie (*G. Sweet*; Colln. Sweet, Melbourne)—Gympie Beds. The longitudinally elongated variety is from Banana Creek (*H. Mackay*; Colln. De Vis).

\* Pl. xvi, fig. 1.

† Ann. and Mag. Nat. Hist., 1847, xx., p. 234, t. 13, f. 5 and 6.

**MARTINIOPSIS ? SUBRADIATA, var. MORRISII, var. nov., Pl. 11, figs. 12 and 13. ?**

*Spirifer subradiatus*, Morris in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 15, f. 5 (non t. 15, f. 5 a and d, t. 16, f. 1-4).

*Spirifera glabra*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, t. 12, f. 1, 1a, t. 11, f. 8 (non t. 12, f. 1b, 1c).

*Var. Char.* Shell round-oval, convex, width and height approximately equal, or but very slightly different, hinge-line much shorter than the width of the shell; ventral area well developed, ventral umbo usually somewhat depressed and channelled, but not greatly incurved; dorsal fold high, broad, and undivided; sinus very broad and deep, continuous with the channelling of the umbo, and limited on each side by a prominent obtusely rounded fold; surface quite plain with the exception of growth laminae.

*Obs.* I propose to distinguish by the above varietal name those forms of *M. subradiata* in which the longitudinal measurement is at least equal to the transverse, and at times exceeds it, giving rise to an oval outline. Such a variety is represented by the figure of Morris above quoted. This shape is accompanied by a very pronounced fold and sinus, the former being limited laterally by a depression and corresponding fold on each side, and the latter by bounding obtuse ridges, or folds. The true *M. subradiata* is much wider than high, as expressed by Mr. G. B. Sowerby,\* who says, "The breadth of this shell is rather greater than its length."

A very closely allied shell, so far as external appearance goes, is *Spirifera hombronianus*,† D'Orb., in which the umbo is grooved, even quite to the apex of the beak.

At times this variety assumes one or two other rib-like folds in addition to those bounding the fold and sinus. I have seen one example with three ribs on each flank, and three others with two. An additional one is visible in Morris's figure.

*Loc. and Horizon.* Spring Creek, Cania, Burnett (*W. H. Rands*)—Gympie Beds.

**MARTINIOPSIS DARWINII, Morris, sp.**

Pl. 9, figs. 13 and 14; Pl. 39, figs. 5-7.

*Spirifer Darwinii*, Morris, Strzelecki's Phys. Descrip. N. S. Wales, 1845, p. 279 (non De Koninck).

„ *subradiatus*, Morris, *loc. cit.*, t. 15, f. 5a (fig. *cæct exclusis*—non G. B. Sowerby).

„ *Darwinii*, Dana, Geology Wilkes' U. S. Explor. Exped., 1849, Vol. x., p. 684, Atlas, t. 1, f. 7.

„ *Darwinii*, Etheridge fil., Proc. R. Phys. Soc. Edinb. 1880, v., p. 281, t. 7, ff. 7-10, t. 8, f. 11.

*Sp. Char.* Transversely ovoid, very convex, gibbous and deep, with the valves equally convex; hinge-line very short, much less than the width of the shell; alar angles regularly rounded; alar expansion, or lateral portions of the shell, short, rounded, and attenuating but little outwards; front margin deeply sinuated. Ventral valve convex, depressed from above in the umbonal region, with a very deep, broad, and pronounced sinus, plain and without subdivisions of any kind; cardinal process depressed, not high, quite horizontal; umbo but little incurved; area short and broad. Dorsal valve very convex in the middle line, quite "pigeon-breasted," with a high, much pinched up, and very straight-sided fold, horizontal in the umbonal region, projecting to the front sometimes far beyond the lateral front edges of the valves, and subdivided in casts for about half its length by a narrow slit, indicating the presence of a thin septum; area small. The dental processes, and their extensions in the ventral valve, are very thick, almost completely surrounding the muscular impressions; the latter deeply excavated, and lingual in outline, convex medianly. The septal processes of the dorsal valve are very thick and short; combined muscular impressions almost

\* Darwin's Geol. Obs. Volc. Islands, 1844, p. 159.

† Dumont D'Urville's Voy. au Pôle Sud, Geol. Atlas, t. 6, ff. 15-18.

confined to the ridge, or the fold. Surface of the valves plain, but the fold and sinus are sometimes followed by one, two, three, or even four sharp, well-separated, radiating costæ on each side, at times well marked, at others very faint and indistinct; the interspaces between these costæ are always much wider than the latter, whilst on the dorsal valve the fold is followed by a deep valley on each side.

*Obs.* In this species, as in the former, I have had the advantage of studying both good internal casts and examples with the test preserved. If *Spirifera subradiata*, G. B. Sby., is correctly placed in *Martiniopsis*, the present species will also fall into that genus, as their internal structure is on the same general plan. The chief points of interest in *M. Darwinii* are the very convex, deep, and equal valves, large fold, and highly pinched-up sinus; but above all the strange horizontal truncature of the umbonal regions of both valves, giving to the shell a square-topped or "pigeon-breasted" appearance, the truncated cardinal process and the fold of the dorsal valve forming, by their imaginary union, almost a right angle. It is this feature, with the marked convexity of the valves, which serves to distinguish *M. Darwinii* from *M. subradiata*.

I am quite in accord with Prof. De Koninck in referring one of the shells figured by Professor Morris as *Spirifera subradiata*, G. B. Sowerby, to the present species, after comparison with Morris's type.\* In justice to Prof. Morris, it must be borne in mind that he himself hinted at this union. Beyond this, however, I cannot go with this much-lamented and distinguished Palæontologist in his interpretation of *Spirifera Darwinii*. To me all his figures of this species represent but a variety of *Martiniopsis subradiata*, to which on a previous page I have ventured to apply the varietal name of *Konincki*. Morris but very briefly described his *S. Darwinii*, and did not ostensibly figure it. In the description, my former Master refers to the equally convex valves, and says—"It is a very neat shell, and presents some resemblance to one of the varieties of *S. subradiatus* (Pl. xv., fig. 5a)." This so-called variety I take to be the veritable *S. Darwinii* of Morris, because the shell in question does not correspond at all with *M. subradiata*, but possesses peculiar features of its own. An examination of the figure quoted will show how widely it differs from any illustrations of the last-named species, whether those of Morris or De Koninck; and no better term could have been employed in its description than that of "neat." Compare the elegantly alate appearance of the sides possessed by "Pl. xv., fig. 5a," with the gradually compressed and elongated ends of the figures given by Morris of the *Spirifera subradiata*.

The muscular scars in the ventral valve are lingual, and in casts very prominent, the surface more or less hollowed or concave. In the dorsal valve the impressions are almost confined to the apex of the fold, and are separated by a septum.

A good deal of variation occurs in the radiating costæ of the exterior. In some individuals there is a single and indistinct rib, in others one well marked and another faint, or they become more numerous as described above.

The internal processes project much less into the interior of the shell than do those of *M. subradiata*, and, although quite as large, produce shallower impressions in casts.

At Yatton, there appears to be a variety of this species differing from the species proper in having the ribs closer, rounded, and rather curved, but this is accompanied by the peculiarities of the cardinal process mentioned above.

*Loc. and Horizons.* Coral Creek, Bowen River, below Sonoma Road-crossing (*R. L. Jack*); Parrot Creek, Bowen River, four and a-quarter miles up (*R. L. Jack*); Richards' Homestead, three miles south-west of Mount Britton Township, (*A. L. Morisset*)—Middle or Marine Series of the Bowen River Coal Field; Yatton Gold Field (*R. L. Jack*)—Gympie Beds.

\* Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 15, f. 5a.

## Family—NUCLEOSPIRIDÆ.

Genus—*RETZIA*, King, 1850.

(Mon. Permian Foss. England, p. 137.)

*RETZIA RADIALIS*, Phillips, sp., Pl. 11, figs. 24 and 25.*Terebratula radialis*, Phillips, Ill. Geol. Yorksh., 1836, Pt. 2, p. 223, t. 12, f. 40 and 41.*Retzia radialis*, Davidson, Mon. Brit. Carb. Brach., 1860, Pt. 3, p. 87, t. 17, f. 19-21.

*Obs.* Numerous examples of a small Brachiopod, always in the form of casts, with a highly punctate structure, and radiating ribs, are to be met with in the Star Beds, usually compressed almost flat, and sometimes obliquely distorted. The radiating costæ appear to be about fourteen or fifteen in number, angular, sharp, and prominent, which, with the valleys between, are densely sprinkled with rugosities representing the very fine punctations of the shell.

The ribs ornamenting the valves are much too numerous for the Devonian *Retzia ferita*, Von Buch, and still more so for the Carboniferous *R. ulotrix*, De Koninck, in which there are only from seven to nine, and very prominent, giving a much bolder appearance than that possessed by the Corner Creek shell. It is with *Retzia radialis*, Phillips, that the greatest resemblance exists, both in size, number of the costæ (eleven to twenty-three), and probably also in shape. So far as I am aware, only one species of *Retzia* has hitherto been described from Australian rocks, and that a Silurian species, viz., *R. Salteri*, Davidson, by Prof. De Koninck. The occurrence of another species in North Australia is therefore an interesting fact.

*Loc. and Horizon.* Corner Creek, Great Star River (*R. L. Jack*)—Star Beds.

*RETZIA ? LILYMERENSIS*, sp. nov., Pl. 11, figs. 20-22.

*Sp. Char.* Shell elongately deltoid, attenuated or narrow towards the beaks, and expanded towards the front; valves equally convex at a point drawn through them immediately below the beak of the dorsal valve, thence rapidly decreasing towards the front margin, which is very wedge-like; umbo of the ventral valve moderately large (its apex broken), and probably overhanging that of the dorsal valve but little; surface of both valves covered with close, equal, simple and rounded costæ, [shell structure punctate?].

*Obs.* The reference of this shell to *Retzia* is provisional only, the nature of the interior being quite unknown. It possesses much the outward appearance of a *Retzia*, but repeated and close examination has quite failed to detect perforation of the shelly matter with any degree of certainty.

In form, *R. ? lilymerensis* is very like some of the genera figured by Dr. W. Waagen from the Productus Limestone of the Salt Range, Hindostan, such, for instance, as *Hemiptychina*, Waagen,\* and *Dielasma* and *Notothyris*, Waagen,† but without possessing the forward plicæ or ribs of these genera. Could I have satisfactorily shown the presence of a punctate shell structure in the present species, it might very justifiably have been referred to *Dielasma*, as the three septal plates visible on the umbonal surface of the dorsal valve, in both shells, closely correspond. Although the Australian shell is not coarsely plicate, it bears a large number of smaller costæ, which certainly do become larger and coarser towards the front margin, after the manner of Waagen's genus.

\* Pal. Indica (Salt Range Fossils), 1882, Ser. xiii., Vol. i., No. 4, fasc. 1, p. 361.

† *Ibid.*, p. 359.



In external appearance, our shell equally resembles the genus *Acambona*, C. A. White,\* but here again a want of knowledge of its internal characters, and the apparent absence of a punctate test, preclude any definite reference.

The only Australian fossil having any resemblance to *R. ? lilymerensis* is *Atrypa plicatella*, De Koninck,† from the so-called Lower Devonian of New South Wales, which has a similar sculpture, but is very much less deltoid and attenuated towards the umbones.

*Loc. and Horizon.* Blenavon, Lilymere, near Rockhampton (*The late James Smith*)—Gympie Beds.

#### Family—ATHYRIDÆ.

Genus—*ATHYRIS*, McCoy, 1844.

(Synop. Carb. Limest. Foss. Ireland, p. 146.)

*ATHYRIS ROYSII*, Leveillé, sp., Pl. 11, fig. 15.

*Spirifer Roysii*, Leveillé, Mém. Soc. Geol. France, 1835, ii., p. 39, t. 2, f. 18-20.

*Athyris Roysii*, Davidson, Mon. Brit. Carb. Brach., 1858, Pt. 2, p. 84, t. 18, f. 1-11 (*for synonymy*).

*Obs.* Two crushed examples, not to be distinguished from this widely distributed shell, were obtained by the late Mr. James Smith, with the characteristic spines exposed as a frill around the margin of the valves, each separate from its neighbour, a character which at once separates *A. Roysii* from the allied *A. planosulcata*. The shell figured by Prof. De Koninck‡ under the latter name does not, as portrayed, exhibit, to my mind, the slightest resemblance to the species in question. The difficulty of correct identification is further increased by the careless manner in which the references in the text are made to the figures on the plates, a fault which more or less pervades the whole work. Through this, it is at times difficult to understand to which figure the Professor is referring in his descriptions.

In the Cawarral Serpentine Mr. Smith found the impression of a Brachiopod, which is either a perforate *Spirifera* of the group *Reticularia*, or an *Athyris*, probably the latter.

*Loc. and Horizon.* Stony Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

*ATHYRIS AMBIGUA*, J. de C. Sowerby, sp.

*Spirifer ambiguus*, J. de C. Sowerby, Min. Con., 1822, iv., p. 105, t. 376.

*Athyris ambigua*, Davidson, Mon. Brit. Carb. Brach., 1858, Pt. 2, p. 77, t. 15, f. 16-22 (*for synonymy*).

*Obs.* A crushed, but at the same time readily recognisable specimen of this equally characteristic shell has been found by Mr. W. H. Rands. Although only a cast the sulcus of the ventral valve is still traceable, and there are indistinct remains of concentric ornamental lines of growth.

*Loc. and Horizon.* Hawkins' Gully, Kariboo Creek, Kroombit Diggings, Port Curtis (*W. H. Rands*)—Gympie Beds.

*ATHYRIS RANDSI*, sp. nov., Pl. 11, figs. 16-18.

*Sp. Char.* Shell obovoid, gibbous, ball-like; valves almost equally convex; ventral valve very convex, the umbo but little elevated; sinus imperfectly visible on the body of the valve, but broad towards the front. Dorsal valve convex and gibbous, especially

\* Proc. Boston Soc. Nat. Hist., 1862, ix., p. 27 (*vide* De Koninck, Faune Calc. Carb. Belgique, 1887, Pt. 6, p. 96).

† Foss. Pal. Nouv.-Gales du Sud, 1877, Pt. 3, t. 3, f. 4 and 4a.

‡ Foss. Pal. Nouv.-Gales du Sud, 1877, Pt. 3, t. 9, f. 6.

about the umbonal region, with a prominent and elevated, but rounded fold, rendering the shell more or less trilobed. Front margin sinuated, much elevated medianly and depressed laterally. Foramen small, and contiguous to the dorsal valve. Surface very plainly concentrically lined, and rather strongly radiately striated (? spine bases).

*Obs.* This species appears to be nearly related to *Athyris subtilita*, Hall,\* which is described as possessing "faint, often almost imperceptible, radiating striæ." In the present species the striæ, if they be so, and not spine bases, are much too coarse to come within this definition. It certainly agrees better with the American shell than it does with the form described by Dr. Abich as *Athyris (Spirigera) protea*, var. *subtilita*, Hall, from the Carboniferous rocks of Armenia.† *Athyris globularis*, Phill., is another shell with which the present may be compared in a general way.

*Loc. and Horizon.* Hawkins' Gully, Kariboe Creek, Kroombit Diggings, Port Curtis (*W. H. Rands*)—Gympie Beds.

### Family—RHYNCHONELLIDÆ.

*Genus*—*RHYNCHONELLA*, *Fischer*, 1809.

(Notice Foss. Gouv. Moscou, p. 35.)

*RHYNCHONELLA PLEURODON*, *Phillips*, sp., Pl. 11, fig. 23.

*Terebratula pleurodon*, Phill., Ill. Geol. Yorksh., 1836, Pt. 2, p. 222, t. 12, f. 25-30 (non 16).

*Rhynchonella pleurodon*, Davidson, Mon. Brit. Carb. Brach., 1860, Pt. 3, pp. 101 and 246, t. 23, f. 1-15, 16-23 ?.

" " De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 219, t. 9, f. 4-4a.

*Obs.* A number of decorticated impressions, resembling *Rhynchonella pleurodon*, occur on the surfaces of blocks from Stanwell, associated with *Chonetes*, *Productus*, and other shells. It is the variety with three or four ribs in the sulcus, and the fold much produced forward. In the dorsal valve the flanks each carry four ribs.

*Loc. and Horizon.* Stony Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds; Gully rising in cliff between two peaks of a mountain, on left bank of Keelbottom River, north of Old Plum-tree Inn (*R. L. Jack*)—Star Beds.

### *RHYNCHONELLA*, *sp. ind.*

*Obs.* A single small shell, ovately trigonal in shape, with a small sharp beak, small convexity of valves, and the dorsal valve bearing twelve angular ribs, simple and without imbricating striæ. It is not unlike a *Retzia*, but the shell substance is impunctate. It might pass for a small variety of *Rhynchonella pleurodon*, but the dorsal valve is rather too flattened in the middle line.

*Loc. and Horizon.* Township, Cania Diggings, Burnett (*W. H. Rands*)—Gympie Beds.

### Family—ORTHIDÆ.

*Genus*—*ORTHIS*, *Dalman*, 1828.

(Kongl. Vet. Acad. Handlingar, 1827 [1828], p. 96.)

*ORTHIS RESUPINATA*, *Martin*, sp., Pl. 11, figs. 26 and 28.

*Orthis resupinata* (Martin), Davidson, Mon. Brit. Carb. Brach., 1861, Pt. 4, p. 130, t. 29, f. 1-6, t. 0, f. 1-5.

*Obs.* Internal casts of this cosmopolitan species, in a good state of preservation, are to be found in the Star River Beds, of all sizes up to one and a-half inches in breadth. They resemble the small forms figured by Mr. Davidson from Millicent,\* in

\* Stanbury's Exped. Valley Gt. Salt Lake of Utah, 1852, App. E, p. 409.

† Geol. Forschungen in den Kaukasischen Ländern, 1878, t. 8, f. 10-12.

Ireland, even to the broad sulcus in the front part of the ventral valve. A few of the specimens are rounder and deeper, and approach the figure given by the same Author of examples from Yorkshire.† A few external impressions have also been obtained, in some of which I believe it is possible to trace the characteristic spines. The largest specimens, however, both external impressions and internal casts, have been collected by the late Mr. James Smith, at Stanwell.

Prof. L. G. De Koninck united *Orthis australis*, McCoy, with this species, and in this I followed him in the "Catalogue of Australian Fossils." But on looking into the matter again it seems to me that a good deal may be said for the separate retention of the latter as a species. By its general outline and form, *O. australis* appears to be a much nearer ally of *Orthis Michelinii*.

*Loc. and Horizon.* Corner Creek, Great Star River (*R. L. Jack* and *P. W. Pears*)—Star Beds; Stony Creek, Stanwell, near Rockhampton (*The late James Smith*); Gracemere Ridges, Stanwell, near Rockhampton (*A. F. Wood*)?; Athelstane Range, Rockhampton (*The late James Smith*); Hawkins' Gully, Kariboe Creek, Kroombit Diggings, Port Curtis (*W. H. Rands*)—Gympie Beds.

*ORTHIS AUSTRALIS*, McCoy, Pl. 11, figs. 27 and 29.

*Orthis australis*, McCoy, Ann. and Mag. Nat. Hist., 1847, xx., p. 234, t. 13, f. 4 and 4a.

*Obs.* Internal casts and external impressions have been collected in the Rockhampton District both by Mr. C. W. De Vis and the late Mr. James Smith. Some of these closely resembled *Orthis Michelinii*, Leveillé,‡ but differed from this well-known European species in possessing proportionately longer, narrower, and more reniform cardinal muscular impressions. In addition to this, the adductor impressions were also much smaller. I think there can be little doubt, however, that *O. australis*, McCoy, is the representative of the other species in Australian rocks. The adductor impressions are simple, as in *Orthis resupinata*, but more heart-shaped, and not double as in *O. Michelinii*, but beyond this the only other points of difference are those stated above. The pedicle scar is strong and well marked (Pl. 11, fig. 29), but the ovarian impressions are not apparent; and, lastly, the dental plates are certainly longer for the size of the shell than in *O. Michelinii*.

*Loc. and Horizon.* Stony Creek, Stanwell (*The late James Smith*)—Rockhampton District; § (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

#### Family—STROPHOMENIDÆ.

*Genus*—*STROPHOMENA* (*Rafinesque*, 1820), *Blainville*, 1824.

(Dict. Sci. Nat., xxxii., p. 302.)

*STROPHOMENA RHOMBOIDALIS*, var. *ANALOGA*, *Phillips*.

Pl. 12, figs. 8 and 9; Pl. 40, fig. 6.

*Producta analoga*, Phillips, Ill. Geol. Yorksh., 1836, Pt. 2, p. 215, t. 7, f. 10.

*Strophomena rhomboidalis*, var. *analoga*, Davidson, Mon. Brit. Carb. Brach., 1860, Pt. 3, p. 119, t. 28, f. 1-13 (for general synonymy).

" " " Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., pp. 331 and 333 t. 15, f. 3 and 5?, t. 16, f. 7, t. 18, f. 1.

" " " Etheridge fil., Cat. Australian Fossils, 1878, p. 60.

*Obs.* This shell occurs in the Silurian, Devonian, and Carboniferous rocks over large areas of the globe, and abundantly in the Permo-Carboniferous Series of the

\* Mon. Brit. Carb. Brach., 1861, Pt. iv., t. 30, f. 1.

† *Ibid.*, t. 30, f. 3.

‡ Mem. Soc. Géol. France, 1835, ii., p. 39.

§ See note, p. 199.

Gympie gold-bearing beds. The latter differs in no respect from the well-known forms described by Wahlenberg, Sowerby, Phillips, De Koninck, and Etheridge.

The later collections of my Colleague contain a few examples of this variety exhibiting its character in a more satisfactory manner than those obtained by the late Mr. Daintree, as, for instance, one specimen in which the vertical smooth front of the shell is visible. A single individual was likewise obtained from the Great Star Beds—a small dorsal valve exhibiting the characteristic transversely corrugated surface. Some very interesting examples of this protean species are in the Queensland Museum, both internal casts and examples retaining a large proportion of shelly matter, with the corrugations on the visceral surface, general fine striæ, and bold vertical front fully preserved. One cast of the interior exhibits, not only the muscular impressions, but also the vascular system.

*Loc. and Horizon.* Lady Mary Reef, Gympie (*The late R. Daintree*); Gympie (*R. L. Jack*); Rockhampton District \* (*C. W. De Vis*; Colln. De Vis)—Gympie Beds; Corner Creek, Great Star River (*R. L. Jack*)—Star Beds.

*Genus—DERBYIA, Waagen, 1884.*

(Pal. Indica. (Salt Range Fossils), Ser. xiii., Vol. iv., fas. 3, p. 591.)

*DERBYIA SENILIS, Phillips, sp., Pl. 12, figs. 1-6.*

*Spirifer senilis*, Phill., Ill. Geol. Yorksh., 1836, ii., p. 216, t. 9, f. 5.

*Streptorhynchus crenistria*, var. *senilis*, Davidson, Mon. Brit. Carb. Brach., 1861, Pt. 4, t. 27, f. 2-7.

*Leptæna senilis*, McCoy, Brit. Pal. Foss., 1853, fas. 3, p. 45a.

*Orthotetes crenistria*, var. *senilis*, Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 282, t. 8, f. 12-15.

*Derbyia senilis*, Waagen, loc. cit., p. 593.

*Obs.* Accepting Dr. W. Waagen's separation of the genera *Streptorhynchus* and *Orthotetes*, and the redistribution of species between them and his new genus *Derbyia*, it is at once apparent that the Australian shell I have described as *O. crenistria*, var. *senilis*, will fall into the last-named, and regain its specific position as originally described by Phillips. It appears to me to have a much greater affinity with the British shells than with any of those described from the Carboniferous Beds of the Indian Salt Range Series by Dr. Waagen.

The Queensland specimens have, in common with British examples, the semi-conic ventral valve, with step-like interruptions "produced by two or three very large and irregular concentric undulations," the elevated, but not incurved beak, and the wide area with its convex deltidium. Similarly, the dorsal valve exhibits the straight hinge-line, evenly convex surface, and much less marked undulations. The striation of the valve likewise appears to be identical, and there are also the same concentric laminations of the area and deltidium as seen in some British examples. Dr. Waagen, in defining *Derbyia*, says nothing about the punctate nature of the shell, but in the present examples the shelly matter is decidedly and distinctly punctate, and when the surface is at all worn the punctæ are everywhere visible, and more especially on the area. I believe the punctate structure of the shell in *Orthotetes* and *Streptorhynchus* has not been generally recognised, for in the generic descriptions given by all the best authors the shell is said to be impunctate. However, that most accurate observer, Professor W. King, has not omitted to notice this peculiarity in the Permian species *Streptorhynchus pelargonatus*, Schlotheim.† Mr. Davidson has also seen the same structure in some British *Orthotetes*.

\* See note, p. 199.

† Mon. Permian Foss. England, 1858, p. 109.

The punctæ on the exterior of the shells appear as small rugosities scattered at random over the surface of the ribs or striæ, and intervening valleys, ornamenting these shells, but when worn to any extent their perforate character at once becomes apparent. They are, in particular, very numerous on the area and deltidium.

The cardinal process is developed in a high degree in this species. It extends, not only partially under the pseudo-deltidium of the ventral valve, as described by Mr. Davidson \* in *Orthotetes crenistria*, but completely under it for some distance. In the present specimens it is a long, rather shoe-horn shaped, testaceous projection, extending either at right angles, or nearly so, from the umbonal centre of the hinge-line. In one or two cases it is quite at right angles, in others it is inclined upwards. In ordinary forms of *Orthotetes crenistria* the cardinal process is bidentate at the outer end, but in the present case the terminal expanded bidentation is flanked by a lateral projection on each side and always more or less perceptible, but at times much more marked than at others, and when so considerably increasing the width of the process.

These prominent examples of *Orthotetes senilis* to some extent resemble the variety *robusta*, Hall, figured by Dr. Davidson from Indian Carboniferous rocks,† only, in the latter, the ventral valve appears wider across the hinge; the umbo, however, projects upwards and backwards, as in the Queensland examples.

*Loc. and Horizon.* Pelican Creek, three-quarters of a mile above Sonoma Road-crossing (*R. L. Jack*)—Middle or Marine Series, Bowen River Coal Field; Havilah-Byerwin Road, one mile south of Rosella Creek-crossing (*R. L. Jack*). The geological position of this species in the Bowen River Coal Field is both interesting and peculiar. According to my Colleague's notes, the first locality above given is in his Middle or Marine Series, while the second locality is in a marine band, in his Upper or Freshwater Series, which is characterised by the predominance of the much-disputed genus *Glossopteris*, and other so-called Oolitic plants.

#### Family—PRODUCTIDÆ.

*Genus*—*PRODUCTUS*, *J. Sowerby*, 1814.

(*Min. Con. i.*, p. 153.)

*Obs.* The *Producti* of the Eastern Australian area form a peculiar and interesting group in themselves. The identity of many of the species with those of Europe is, I think, vague. We certainly possess *Productus cora*, D'Orb., or, at any rate, a form so like it that I am unable to refer to any difference, whilst other species have from time to time been referred by Authors to *P. longispinus*, *P. scabriculus*, *P. semireticulatus*, and others. I have made use of these terms even in the present Memoir, but I feel that they are but names used to distinguish some cast or weathered specimen having a fancied resemblance to the species in question. Nine-tenths of our *Producti* are but casts, and therefore very difficult to determine, and it is not until a long and close study of such from many localities has been made, that the number of species actually existing can be put on a satisfactory footing. The species, however, are few, and it is not improbable that this decrease in number has to some extent been compensated for by the increase, both in species and their importance, of the genus *Strophalosia*.

Long research leads me to the belief that great community of form existed amongst the *Producti* of Queensland, New South Wales, and Tasmania.

Of the only two species of which sufficiently complete specimens have been found to render their entire examination satisfactory, both are now known to possess an area, usually well marked, always certainly present.

\* *Mon Brit. Carb. Brach.*, 1858, Pt. 4, p. 30.

† *Quart. Journ. Geol. Soc.*, xviii., p. 30, t. 1, f. 16.

PRODUCTUS CORA, *D'Orbigny*.

Pl. 12, fig. 14; Pl. 13, fig. 1; Pl. 38, fig. 11.

- Productus cora*, D'Orbigny, Pal. Voy. Amérique Mérid., 1842, iii., Pts. 3 and 4, p. 55, t. 5, ff. 8 and 9.  
 „ „ Davidson, Mon. Brit. Carb. Brach., 1861, Pt. 4, p. 148, t. 36, f. 4, t. 42, f. 9.  
 „ „ Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 328, t. 15, ff. 1 and 2.  
 „ „ Etheridge fil., Cat. Australian Foss., 1878, p. 51.  
 „ „ De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 184, t. 9, f. 1.

*Obs.* *P. cora* was first detected as a Queensland fossil by Mr. Etheridge in the Collection made by the late Mr. R. Daintree. His remarks were as follows:—"Our shell was evidently very thin and fragile, with a gibbous ventral valve, the surface covered with straight, wavy, or flexuous longitudinal thread-like striæ or ribs, and few spines. The dorsal valve shows the rugose undulating folds or wrinkles at the cardinal angles. We fail to see the concentric lines crossing the ribs on our examples, owing to their condition; and the places of former spines are faintly traceable."

The surface of slabs of the chloritic rock of Gympie are often covered with crushed examples of this species, and my Colleague has collected a number of similar smaller *Producti*, both dorsal and ventral valves, which are probably identical.

Three-quarters of a valve has also been obtained from the Rockhampton Beds, showing the fine regular striation, spinose wings, and coarsely wrinkled flanks of this well-marked species. A second, which may be either *P. cora*, or *P. semireticulatus*, has also been found by Mr. Smith. The flanks of this specimen are too much wrinkled for the former, although the fineness of the striæ would indicate *P. cora* as its proper reference. The character of the wings and the strong spines thereon do not assist in a determination, as these are features common to both species. On the whole, I am inclined to refer this shell, from the Training Wall Quarries, to *P. cora*. Exceedingly well-marked casts have been collected from the rich beds of Mount Britton, by Mr. A. L. Morisset, exhibiting similar features to the Rockhampton specimens.

*Loc. and Horizon.* New Caledonia Reef, Gympie (*The late R. Daintree*); Gympie (*R. L. Jack*); Stony Creek, Stanwell (*The late James Smith*); Training Wall Quarries, Fitzroy River, Rockhampton (*The late James Smith*)—Gympie Beds; South side of Mount Britton (*A. L. Morisset*)—Middle or Marine Series, Bowen River Coal Field.

PRODUCTUS BRACHYTHÆRUS, *G. Sowerby*.

Pl. 12, figs. 10-13; Pl. 13, fig. 5 ?; Pl. 44, fig. 14.

- Productus brachythærus*, G. B. Sby. in Darwin's Geol. Obs. Volc. Islands, 1844, p. 158.  
 „ „ Morris in Strzelecki's Phys. Descr. N. S. Wales, &c., 1845, p. 284, t. 14, f. 4c (non 4a and 4b).  
 „ „ De Koninck, Mon. Genre Productus, p. 241, t. 16, f. 1a and b (non 1c and d).  
 „ „ *subquadratus*, De Koninck (non Morris), *loc. cit.*, p. 203, t. 14, f. 1c and d (? 1a and b).  
 „ „ *brachythærus*, De Koninck, Mon. Productus et Chonetes, 1847, p. 102, t. 16, f. 1a and b (non 1c and d).  
 „ „ *subquadratus*, De Koninck (non Morris), *Ibid.*, t. 14, f. 1c and d (? 1a and b).  
 „ „ *brachythærus*, Dana in Geology Wilkes' U. S. Explor. Exped., 1849, Vol. x., p. 686, Atlas, t. 2, f. 8.  
 „ „ D'Orbigny, in Dumont D'Urville's Voy. au Pôle Sud, 1846, Palæontologie, Atlas, t. 6, f. 6 and 7.  
 „ „ *fragilis*, Dana, American Journ. Sci., 1847, iv., p. 153.  
 „ „ Dana, *loc. cit.*, p. 686, Atlas, t. 2, f. 7.  
 „ „ *brachythærus*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 198, t. 10, f. 4 and 4a (t. 11, f. 1 ?).  
 „ „ *fragilis*, De Koninck, *loc. cit.*, p. 201, t. 10, f. 3 and 3a.  
 „ „ *brachythærus*, Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 284, t. 8, f. 16, t. 9, f. 17 and 18.

*Sp. Char.* Shell of medium size, subtrapezoidal to subrectangular, non-lobate, more or less reflected, or geniculate, and generally gibbous. Ventral valve very gibbous

in the visceral region, vaulted, geniculate, or reflected on itself; surface convexly rounded, no sinus; sides vortical, or even sometimes slightly concave separating the remainder of the valve from the more or less short, flattened, triangular ears; umbonal region often depressed from above, sometimes greatly recurved, and sometimes more or less incurved over the hinge-line; the latter is of median length, but a little less than the width of the valve, sharp and acute; front usually much recurved and occasionally laterally expanded, assisting to give the shell much of its geniculate appearance; beak small and acute; surface, when the outer shell is preserved, shining and silky, with a few growth constrictions towards the front, and indistinct undulations on the umbonal region; longitudinally and indistinctly costated by delicate, elongate, parallel spine bases, within the substance of the shelly matter, penetrating the latter, as small, free, short, tubercle-like spines, giving a general prickly or pimply appearance to the entire valve, especially towards the front. When the thin outer shell is removed, or in decorticated examples, these long spine bases leave a series of fine channels on the surface of the fossil. Ears with numerous tubular spines. The cardinal muscular scars are but little marked; the adductors are straight, and formed of oblique ramifications; surface granular.

The dorsal valve varies in the amount of its concavity, being at times shallow, at others exceedingly concave, especially in the middle line; ears flattened; front produced; surface with concentric lines and spine bases. The septum is moderately short; dendritic adductor impressions small; reniform impressions laterally extended, and well marked; internal surface granular.

*Obs.* *Productus brachythærus* is one of the most interesting species of the genus yet published, and has been much misunderstood by several of those who have written about it. The species is well worth a separate and detailed study. Chance observers examining the various figures hitherto published would be apt to consider them as not all appertaining to one species. If full attention, however, is given to the various aspects under which the shell is found, I believe it can be shown that they one and all represent a single well-marked and peculiar species.

All who have written on *P. brachythærus* lay stress on the shortness of the hinge-line as compared with the width of the front. This, with the elongated decurrent bases of the spines, forming channels in the shell, are particularly characteristic points in G. B. Sowerby's species. The channelling of the shell by the spine bases is seen in many species of *Productus*, but it appears to be peculiarly distinctive of *P. brachythærus*. The length of the hinge-line varies according to age, in large and old individuals it becomes longer, and the shell, which is very convex and geniculate, loses some of its convexity and also widens out.

In describing this species the late Professor John Morris referred to it two shells of very different aspect and state of preservation. One of these is a cast in sandstone, showing the general form, and more particularly the channels formed by the decurrent bases of the spines. The other specimen is a decorticated siliceous cast, and displays the internal characters of both valves to great perfection. On the ventral valve are exposed the node-like prominences of the cardinal muscles, the scars of the more elongated adductor muscles, and the internal cast of the beak. The dorsal valve shows the scars of the adductors, and the cast of the septum, which in this individual reaches almost to the front margin of the valve, an unusual length in the genus *Productus*. The vascular impressions are also preserved and come very far forward, like the septum.

In his Work on the "Genus *Productus*," again in that on "*Productus* and *Chonetes*," and more recently in his "Fossiles Paléozoïques de la Nouvelle-Galles du Sud," Prof. De

Koninck has expressed an opinion that the two shells in question, referred by Morris to *P. brachythærus*, are different, and do not belong to the same species, one being possessed of a short septum in the dorsal valve and less marked muscular scars, the other, on the contrary, with a very long septum and strongly marked scars. In working out the species it became essential for anything like correct determination that some more satisfactory solution of this subject than mere opinion should be arrived at.

The specimens used by Mr. G. B. Sowerby having disappeared, as already explained,\* those contained in Strzelecki's Collection in the British Museum, and described by the late Prof. Morris must be accepted as the types, and to their structure all future appeals must be made in determining the identity of *P. brachythærus*, G. Sow., Morris. Now, as stated above, Prof. De Koninck regards the silicified cast† with the long septum, described by Morris as *P. brachythærus*, to be specifically distinct from the true *P. brachythærus*,‡ a name which he considers should be retained for a form with a short septum, amongst other characters. The silicified cast figured by Morris in Strzelecki's Work (Pl. xiv., ff. 4a and b) has, for one of its most distinctive characters, a long septum in the dorsal valve, as previously pointed out; but the example of *P. brachythærus* represented by the sandstone cast accorded much better with Sowerby's description of his species, than did the siliceous example. The specimen in question,§ as then exposed, was that of a ventral valve backed up with matrix so that on the removal of the latter the cast of the dorsal valve would be visible and the septum exposed, long or short as the case might be. It was found to possess, so far as we are able to judge, a short septum, so probably confirming in a remarkable manner Prof. De Koninck's surmise. The matter then stands thus: The figure given by Morris in Strzelecki's Work on "New South Wales," Pl. xiv., f. 4c, is the true *P. brachythærus*, characterised by the presence of a short septum and a little developed muscular system. On the other hand (Pl. xiv., ff. 4a and b, of the same Work), the siliceous cast, with a very long septum and great muscular development, is a distinct and separate species. McCoy's type specimens of *P. brachythærus*, in the Woodwardian Museum, Cambridge, do not call for any particular notice beyond the fact that they show the species to be in outward appearance not unlike the variety *pugilis*, Phill., of the European species, *P. semireticulatus*, Martin, and a peculiar streaky appearance is given to the exterior of the shell by the decurrent bases of the spines. With regard to McCoy's *P. undulatus*,§ Prof. De Koninck|| refers it to *P. brachythærus*; but a careful examination of the type in the Woodwardian Museum has not convinced me of their identity. I have not seen such peculiar undulating striæ upon any specimen of *P. brachythærus* I have examined.

When well preserved, and not crushed or broken, *P. brachythærus* is a subquadrato shell, high and gibbous in the visceral region, rapidly and deeply sloping off at the sides to the flat, triangular ears. Such a condition is represented by Morris's original figure,¶ one of De Koninck's of his so-called *P. subquadratus*, Morris,\*\* and his earlier figure of *P. brachythærus*†† and his last figure of the same species.‡‡ The ears of this species appear to have been particularly fragile, and more often than not have com-

\* Proc. R. Phys. Soc. Edinb., 1880, v., p. 285.

† Strzelecki, *loc. cit.*, Pl. 14, f. 4a and b.

‡ Strzelecki, *loc. cit.*, Pl. 14, f. 4c.

§ Ann. and Mag. Nat. Hist., 1847, xx., p. 235.

Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 198.

¶ Strzelecki, *loc. cit.*, t. 14, f. 4c.

\*\* Mon. Gen. Productus, t. 14, f. 1e.

†† *Ibid.*, t. 16, f. 1a and b.

‡‡ Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, t. 10, f. 4a and b.



pletely disappeared. When this is the case we find the shell assumes a subtrapezoidal outline, and presents a very different appearance to that previously described. In this state it is represented by another of De Koninck's figures of *P. subquadratus*,\* and my own from the Bowen River Coal Field.† At times a highly geniculate form is assumed by *P. brachythærus*, with various intermediate conditions between this and the former outlines. When much reflected in this way it becomes the *P. fragilis*, Dana,‡ and one of the intermediate forms is shown in another figure of my own from North Queensland.§ In the Mining and Geological Museum, Sydney, is a very geniculate individual from the Bowen River Coal Field, in which the depth through the shell is two inches. These are the forms usually assumed by *P. brachythærus*. The elongated spine bases are clearly contained within the substance of the shell, and when decortication takes place, the spine bases appear to be removed with the outermost shelly layers, leaving long open channels. For quite a third of the height from the front margin, these spine bases are absent, and this portion bears scattered outstanding spines, the intermediate portions being glossy and smooth.

Now, with regard to the reference of *Productus subquadratus* (Morris), De Koninck, and *P. fragilis*, Dana, to this species. *P. subquadratus*, Morris,|| was very briefly described—too briefly, in fact—and in the absence of a figure would have been unrecognizable, had it not been for the fact that Morris says—"Mesial furrow broad and distinct." Herein it differs entirely from *P. brachythærus*. The only figures extant referred to *P. subquadratus* are those published years ago by De Koninck,¶ one of which is an ordinary form of the *P. brachythærus*, a second is that form of this species with the ears broken off, as I have above described: and the identity of the third is doubtful. There can be no doubt about the second figure, the short (broken), erect, sharp hinge, trapezoidal outline, short septum, and no trace of a sinus, are characters not to be mistaken. It is but just to Prof. De Koninck to say that he even doubted the accuracy of his own determination, for he says—"Je ne suis pas entièrement convaincu de la réalité de cette espèce, et je le n'adopte provisoirement qu'en faisant mes réserves pour l'avenir."

*Productus fragilis* was the name given by Prof. J. D. Dana\*\* to the highly geniculate condition of *P. brachythærus*, an opinion I have previously expressed†† and still adhere to. Prof. De Koninck held a contrary view, and has furnished an elaborate description of what he believed to be *P. fragilis*, Dana, in his recent Work.‡‡

So little reliance can be placed on some of the late Prof. De Koninck's descriptions, this amongst the number, that it is extremely difficult to grasp the requisite characters for the detection of the species then running in the mind of the Author. He states that the dorsal valve of *P. fragilis* is "legèrement concave"; but some few lines further on, on the next page, when comparing the species with *P. brachythærus*, he nullifies this statement by saying, "la convexité de sa valve dorsale." It is quite possible, as he observes further on, that the shell he is describing as *P. fragilis* may be identical with the unnamed siliceous casts in Strzelecki's work, previously referred to (t. 14, f. 4a-b). Of the true *P. fragilis*, Dana, however, I am in no doubt. I fail to see how it can be anything more than a variety of the species now under description.

\* Mon. Gen. Productus, t. 14, f. 1d.

† Proc. R. Phys. Soc. Edinb., 1880, v., t. 8, f. 16.

‡ Geology Wilkes' U. S. Explor. Exped., 1849, Vol. x., Atlas, t. 2, f. 17.

§ Loc. cit., t. 9, f. 17 and 18.

|| Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 284.

¶ Mon. Gen. Productus, p. 203, t. 14, f. 1a-d.

\*\* Geology Wilkes' U. S. Explor. Exped., 1849, Vol. x., p. 686, Atlas, t. 2, f. 7.

†† Proc. R. Phys. Soc. Edinb., 1880, v., p. 287.

‡‡ Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 201.

As compared with *Productus scabriculus*, the present one is much more geniculate, but they frequently otherwise resemble one another in shape. Our species does not possess a divided septum in the dorsal valve; but, on the other hand, an area is present, the surface of the dorsal valve is far more concave, and the spine bases on the surface of the ventral valve quite lack the regular and close arrangement of those of *P. scabriculus*.

As a rule, when examined in the state of casts, the muscular scars of *P. brachythærus* do not appear to be highly developed, and, as compared with similar features in *P. subquadratus*, there is a marked difference. But in examples of the former from the Darr River,\* in which the whole of the shelly matter is practically retained, this difference is not of so marked a character, and it is further evident both that the shell attained a very considerable thickness, and that a distinct area was present (Pl. 44, fig. 14). This varies much in breadth, sometimes becoming quite linear, and at other times broad and appreciable.

*Loc. and Horizon.* Stonehumpy Creek, and Pelican Creek, near No. 1 Bore (*R. L. Jack*)—Middle or Marine Series, Bowen River Coal Field; Havilah-Byerwin Road, one mile south of Rosella Creek-crossing (*R. L. Jack*)—Marine band in the Upper or Freshwater Series, Bowen River Coal Field, associated with *Derbyia senilis*; Fenestella Hill, Encrinite Creek, and Stony Creek, Stanwell, near Rockhampton (*The late James Smith*); Limestone, close to Yarrol Station, Burnett (*W. H. Rands*); Spring Creek, Cania, Burnett (*W. H. Rands*)—Gympie Beds; Darr River† (*Prof. A. Liversidge*); Richards' Homestead, three miles south-west of Mount Britton Township (*A. L. Morisset*)—Middle or Marine Series, Bowen River Coal Field.

*PRODUCTUS SUBQUADRATUS*, *Morris*, Pl. 38, figs. 7-10; Pl. 40, fig. 5.

*Productus subquadratus*, *Morris* in *Strzelecki's Phys. Desc. N. S. Wales, &c.*, 1845, p. 284.

„ „ De Koninck, *Mon. Gen. Productus*, p. 203, t. 14, f. 1a and b.

„ „ De Koninck, *Mon. Productus et Chonetes*, 1847, p. 100, t. 14, f. 1a and b.

„ „ Etheridge fil., *Proc. R. Phys. Soc. Edinb.*, 1880, v., p. 288.

*Sp. Char.* Shell large, quadrate-triangular, inflated, gibbous, and very geniculate, being produced much towards the front; when viewed laterally the sides are wall-like, but when seen from the dorsal side the shell has a more expanded appearance. Ventral valve very convex and much curved, inflated about the middle of the shell; a well-marked sinus usually extends from the umbonal region continuously to the front margin, shallowing towards the latter, and giving to the valve a more or less bilobed appearance; sides vertical, and flattened; umbo large, thick, incurved, but not overhanging the hinge-line, or produced beyond it; area short and triangular, transversely striate; pseudo-deltidial aperture triangular and very marked, the area on each side below it sometimes thickened into a blunt prominence (hardly teeth); adductor scars deeply impressed, forming prominent oblong or oval eminences in casts, vertically ridged and grooved, cardinal scars narrow, elongate and deep, the median dividing groove very linear; umbonal cavity much pitted and grooved. Dorsal valve flattened above, becoming concave and geniculate towards the front, when the valve often becomes bent almost in the form of a right angle; hinge-line rather shorter than the width of the valve, with the alar angles rounded; area longer and narrower than in the ventral valve; septum entire, strong, sharp, extending to within a short distance of the front edge, and distally projecting as a thick and strong cardinal process far into the umbonal cavity; alar ridges inconspicuous; adductor impressions in deep depressions,

\* There must be some mistake as to the locality of this example, as the Darr River is wholly in the Rolling Downs Beds. Perhaps the "Don," near Rockhampton, is the river referred to. (*R.L.J.*)

† Locality doubtful. (*R.L.J.*)

circumscribed by the strong prominent encircling ridges, higher than wide, and vertically dendritic; reniform impressions oval, large, and faintly marked, the limbs quite horizontal. Surface of both valves with alternate rows of tear-like tubercles, arranged roughly in quincunx, giving support to short free spines, the whole interrupted by a few concentric undulations.

*Obs.* The above characters are taken both from specimens with the outer shell more or less preserved, and excellent internal casts. It occurs in some profusion near Mount Britton Township, in the latter condition (Pl. 38, figs. 7-10) exhibiting many of the characters in great beauty.

This is probably the largest of the Australian *Producti*, even exceeding *P. cora* in size, which it resembles somewhat in outline. It is remarkable for its massive and geniculate form, wide open sinus, and straight wall-like sides, characters to some extent commented on by Morris.

The umbo of the ventral valve is fairly large for the size of the shell, doubtless to provide room for the large proximal end of the cardinal process, and although incurved, is not produced to overhang the hinge-line.\* Without doubt there is an area in both valves, which is always short and triangular in the ventral, but seems to be longer in the dorsal. That of the former is excellently shown in its most exaggerated form in a specimen from Yatton, in which nearly the whole of the shelly matter is preserved. The area of both valves, when united, is seen in several specimens from Mount Britton, but more particularly on the impression of a large valve, three by three and a-half inches in size, from Lake's Creek. Here the dorsal margin is thickened, forming an area nearly one-eighth of an inch wide, and delicately transversely striate. This, and the triangular pseudo-deltidial aperture, are characters which do sometimes occur in *Productus* proper, as, for instance, in the specimen of *P. semireticulatus* figured\* by the late Dr. T. Davidson, from the English Carboniferous Limestone. He remarked on this—"Possesses sometimes, although rarely, a well-defined area and fissure covered by a pseudo-deltidium." The presence of the blunt protuberances, one on each side of the fissure, have already been referred to in the Yatton shell, and it might be argued that from the presence of these we are dealing with a *Strophalosia*; but the reniform impressions are clearly those of *Productus*, so that any reference to the former must be abandoned. Could we be certain that these callosities represent hinge teeth received into sockets on the opposite, or dorsal valve, the genus *Productella*, Hall,† would put in a much stronger claim. In this genus there are a "narrow area on each valve, a foramen or callosity on the ventral area, small teeth, and more or less distinct teeth sockets." But I am by no means sure that these thickenings are any more than so, and do not actually represent hinge teeth in the sense of those seen in *Strophalosia* and *Productella*.

The adductor muscular scars of the ventral valve are placed low down, and are dendritic (Pl. 40, fig. 5). In *Productus*, as a rule, these scars are elongately reniform, but in a few species, such as *P. humerosus*‡ and *P. lineatus*, Waagen, they resemble the examples now before us. Taking, therefore, the general structure of *P. subquadratus*, it will be found to depart considerably from the restricted description of *Productus*, and marks a transition towards those ponderous and abnormal shells called *Productus comoides* and *P. llangollensis*, by Mr. Davidson.§ In Dr. Waagen's later classification of the *Productida*, these are made the types of a new genus *Daviesiella*,|| and rightly so.

\* Mon. Brit. Carb. Brach., Pt. 4, t. 43, f. 5.

† Pal. N. York, 1867, iv., p. 153.

‡ Mon. Brit. Carb. Brach., 1861, Pt. 4, p. 147, t. 36, f. 1 and 1b.

§ Loc. cit., 1862, Pt. 5, t. 55, f. 8 and 9.

|| Pal. Indica (Salt Range Fossils), 1884, Ser. xiii., Vol. i., No. 4, fas. 4, p. 613.

They, however, differ from *Productus*, restricted, in the presence of supplementary adductor scars, which are certainly not visible in any of the Australian specimens examined by me. Under these circumstances, *P. subquadratus* must for the present remain in the older genus, although it would probably simplify the classification of such intermediate forms if another genus were established for them, differing from *Productus* as above indicated, and agreeing with *Daviesiella* in all but the character named. The casts of both the dorsal and ventral valves are much pitted towards the front margin, and the general surface of the former is covered with pockmark-like depressions.

*P. subquadratus* is distinguished from *P. brachythærus* by its much larger size, sinus of the ventral valve, length of the septum, much larger area, and lastly the dendritic adductor scars of the ventral valve.

There are some points in common between the present species and *Productus scabriculus*, Martin, such as the bilobate form of the ventral valve, the sinus, and generally speaking, the ornamenting spines. Unlike the British species, however, our form is remarkably geniculate, is really more deltoid, and not so transverse. Furthermore, the septum is here entire, of great length and development, and the reniform impressions much more lateral in position, and placed lower down. A single specimen of *P. scabriculus* has been recorded by De Koninck from New South Wales, and the description leads me to infer that the Author had before him some condition of the present species.

Near to *P. subquadratus* is *Productus Purdoni*, an Indian species described by the late Dr. Davidson,\* both in the form of the shell and general surface characters; but the Indian species is not geniculate, and has a pronounced fold in the dorsal valve. Neither of the numerous examples of the former shell examined by me have shown this, nor the fine reticulation of the surface described in *P. Purdoni* by Dr. Waagen.†

Before concluding, a few words must be said about the siliceous cast figured by Morris as *Productus brachythærus*,‡ and which, although now known not to be that species, is at the same time in want of determination. It possesses many points in common with *P. subquadratus*, and in the figure there is a very suspicious indication of an area. If the ventral adductor scars could only be shown to be dendritic, the resemblance would be complete. I think it not impossible that we are dealing here with a small and short form of the present species.

*Loc. and Horizon.* Richards' Homestead, three miles south-west of Mount Britton Township (*A. L. Morisset*); Pelican Creek, two and a-half miles above Sonoma Road-crossing (*R. L. Jack*)—Middle or Marine Series of the Bowen River Coal Field Lake's Creek, near Rockhampton (*The late James Smith*); Yatton Gold Field (*R. L. Jack*)—Gympie Beds.

#### PRODUCTUS UNDATUS, DeFrance, Pl. 12, fig. 16.

*Productus undatus*, DeFrance, Dict. Sci. Nat., 1826, xliii., p. 354.

- " " Davidson, Mon. Brit. Carb. Brach., 1861, Pt. 4, p. 161, t. 34, f. 7-13.
- " " De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 190, t. 11, f. 4.
- " " Etheridge fil., Cat. Australian Foss., 1878, p. 53.

*Obs.* This species is known only by a single specimen, exhibiting the regular concentric undulations characteristic of it. The latter are much more uniform and continuous than those on the figure of the example from New South Wales given by

\* Quart. Journ. Geol. Soc., 1861, xviii., p. 31, t. 2, f. 5a and b.

† Pal. Indica (Salt Range Fossils, 1884, Ser. xiii., Vol. i., Pt. 4, fasc. 4, p. 705, t. 73, f. 1-3.

‡ Strzelecki's Phys. Descrip. N. S. Wales, &c., t. 14, f. 4a and b.

Prof. De Koninck. The terrace-like undulations are much too pronounced and coarse for the wavy lines ornamenting the surface of *P. undulatus*, McCoy,\* otherwise there is some resemblance between the two forms.

*Loc. and Horizon.* Stony Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

PRODUCTUS SEMIRETICULATUS, *Martin*, sp. ?

*Conch. (Anomites) semireticulatus*, Martin, Pet. Derb., 1809, t. 32, f. 1 and 2, t. 33, f. 4.

*Productus semireticulatus*, Davidson, Mon. Brit. Carb. Brach., 1861, Pt. 4, p. 149, t. 43, f. 1-11, t. 44, f. 1-4.

" " De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 188, t. 9, f. 2.

*Obs.* Small, partially decorticated casts, with the long hinge-line, alar spines, and chequered surface of this species have been collected by Mr. James Smith and Mr. Rands. The length of the hinge-line, amongst other characters, distinguishes it from *P. brachythærus*.

*Loc. and Horizon.* Stony Creek, Stanwell, near Rockhampton (*The late James Smith*); Spring Creek, Cania, Burnett (*W. H. Rands*)—Gympie Beds.

PRODUCTUS LONGISPINUS, *J. Sowerby*, ? Pl. 13, fig. 2.

*Productus longispinus*, J. Sby., Min. Con., 1814, i., p. 154, t. 68, f. 1.

" " Davidson, Mon. Brit. Carb. Brach., 1861, Pt. 4, p. 154, t. 35, f. 5-19 (*for general synonymy*).

" " Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., Pt. 3, p. 333, t. 18, f. 9.

*Obs.* This common and widely spread shell is the most variable of the *Producti*, and seldom attains a larger size than our specimen, which is a cast of the interior of the dorsal valve. It is known in the Carboniferous Limestone of the Punjab, in India, Carro Creek in Tasmania, Bolivia, Russia, and Belgium, and everywhere in Britain; we now, for the first time, record it from Queensland. (*Etheridge*.)

*Loc. and Horizon.* Don River (*The late R. Daintree*)—Gympie Beds.

PRODUCTUS, *sp. ind. (a)*, Pl. 13, fig. 6.

*Obs.* A peculiar form which must, for the present, from the want of sufficient material, remain undetermined, has been obtained in the Burnett District. Specimens consist of decorticated casts, with well-separated, distinct, fine, string-like radiating costæ. Such are found in some varieties of *Productus giganteus*, Martin. They are not reticulate like *P. semireticulatus*, and the ribs are too coarse for a variety of *P. cora*, although characters in common with each of these species are present. The sharp and incurved condition of the beak of the ventral valve indicates a transition towards *Productus striatus*, some forms of which occasionally possess coarse striæ.

*Loc. and Horizon.* Near Yarrol Station, Burnett District (*W. H. Rands*)—Gympie Beds.

PRODUCTUS, *sp. ind. (b.)*, Pl. 12, fig. 15.

[Compare *P. fimbriatus* (Sby.), Davidson, Mon. Brit. Carb. Brach., 18 1, Pt. 4, t. 33, f. 13.]

*Obs.* A very remarkable and interesting fragment presented itself on a slab, with other fossils, from the prolific beds of Stanwell, consisting of the outer shell of a *Productus*, seen from the inside. The spine bases are serially arranged in concentric rows, after the manner of those of *Productus fimbriatus*, Sby., whilst around the edge of the shell they are visible in section diverging from the surface of the valve. There is not the irregularity of disposition seen in the spines of *P. aculeatus*, but, on the contrary, the bases are on rather raised concentric rims, as in the species first mentioned.

\* Ann. and Mag. Nat. Hist., 1847, xx., p. 236, t. 13, f. 2.

The umbonal region and hinge-line are, unfortunately, not preserved, and in consequence a direct reference to *Productus* may have elements of doubt, but, at the same time, I cannot satisfactorily compare it to any other Brachiopod. The spines are too coarse and much too far apart for either an *Athyris*, such as *A. Roysii*, or a *Reticularia*, like *R. lineata*. Had it not been for the regular concentric method of arrangement of the spine bases, *P. spinulosus*, J. Sby., might have put in a claim for comparison.

*Loc. and Horizon.* Stony Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

*PRODUCTUS* *sp. ind. (c.)*, Pl. 13, Fig. 4.

[Compare *Productus praelongus* (Sby.), Davidson, Mon. Brit. Dev. Brach., 1865, Pt. 2, p. 602, t. 19, f. 22-25.]

*Obs.* A very remarkable fragment is represented in the above figure. It is the external impression of the ventral valve of a *Productus*, regularly and delicately striate, with a slight median ridge, representing the cast of the mesial sinus, on which are five pits in a line. These are the impressions of spines, and both the position of them and the general appearance of the fossil, strongly recall to mind the structure of *Productus praelongus*, Sby. It is, however, probable that the shell possessed a more regular shape than that species. A similar distribution of spines is met with in *Productus mesolobus*, Phill., to some extent, accompanied by other characters which are not present in our fossil.

*Loc. and Horizon.* Stony Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

*PRODUCTUS*, *sp. ind. (d.)*, Pl. 40, fig. 4.

*Obs.* A small and peculiar, partially decorticated specimen of the *P. costatus* group. It is a ventral valve with a long straight hinge, depressed broad visceral regions, irregularly and concentrically wrinkled, whilst the central front, and that portion of the surface only, bears distinct, fine, and well separated vertical ribs, the sides being free. Some of the ribs bifurcate, whilst others seem to have been spined. The concentric wrinkles are strongly marked on the alar expansions.

Only one example of this peculiar little shell has come under my notice, otherwise I believe the characters are sufficiently peculiar to warrant a name being given to it. The form and nature of the costæ indicate *P. costatus* as the group to which it is referable, but in this species the whole of the front bears ribs, except a very limited portion of the ears, but in our specimen the limitation is a very marked one. In a like manner it differs from the allied Indian species *Productus indicus*, Waagen, *P. vishnu*, Waagen, &c.

*Loc. and Horizon.* Rockhampton District\* (*O. W. De Vis*; Colln. De Vis)—Gympie Beds.

*PRODUCTUS*, *sp. ind. (e.)*, Pl. 37, fig. 18.

[Compare *P. Humboldti*, D'Orbigny, in Waagen, Pal. Indica (Salt Lake Fossils), 1884, Ser. xiii., Vol. i., Pt. 4, fasc. 4, p. 695, t. 76, f. 1-3.]

*Obs.* This peculiar and well-spined form has caused me much trouble, and I am not even now prepared to say to which of the known species it should be referred. It is a decorticated cast of a rather transverse ventral valve, with a moderately long hinge-line, a wide open sinus, a well incurved beak, and vertically elongated, somewhat tear-shaped spine bases arranged roughly in quincunx, those of one row alternating with

\* See note, p. 199.

those of another. The alar expansions are covered with minute short prickles. At one time I took this to be either the young state of *Productus subquadratus*, or a peculiar condition of *P. brachythærus*, and I am not prepared to deny that it may not be one or the other even now. However, in many points the specimen has even a closer resemblance to Dr. Waagen's figures of three Indian species—*P. Humboldti*, D'Orb., *P. Abichi*, Waagen,\* and *P. serialis*, Waagen.† The shape is identical, the clustering of the prickle-like spines on the wings the same, the broad undefined sinus similar, and above all the long tear-like quincuncially arranged body spines in every way like those on our specimen. The only difference I can detect—but this may result from the fact that the latter is not perfect towards the front margin—is the absence of the closely clustered and smaller spines all round the front of the shell, and similar to those on the alar expansions. These form a very marked feature of the Indian shells. Whatever may prove to be the identity of the present form, there remains the fact that we have in the Queensland beds one in many respects closely similar to forms found in India, more particularly that called by Waagen *Productus Abichi*. I say "called" because it seems to me that Dr. Waagen has figured under three separate names what might, with great advantage to science, have been confined to one. All three species, *P. Humboldti*, *P. Abichi*, and *P. serialis*, so closely resemble one another, that I think only the Author himself could separate them. Of the two first, Dr. Waagen candidly states it to be "solely a matter of taste whether the difference be admitted or not as sufficient for the distinction of two separate species." The difference consists simply of a "coarser tuberculation, and by the more elongated form of the tubercles." *P. serialis* is said to differ from *P. Abichi* by a well-developed concentric folding in a more or less close relation to the spines distributed on the surface of the ventral valve. I regard all three species as one, therefore, which may be known under the name of *Productus Humboldti*, as originally determined by Dr. Davidson.‡

There is the bare possibility that this may be a *Strophalosia*. The spines have greatly the appearance of those of this genus, but I have not seen any evidence of the teeth or sockets of the hinge-line. In my Paper on the Permo-Carboniferous Fossils from North-West Australia, I omitted to mention that the shell there named *Productus brachythærus*, and which is certainly the same as that now figured, possessed a depressed vertical groove on the beak, after the manner of some *Strophalosia*.

*Loc. and Horizon.* Richards' Homestead, three miles south-west of Mount Britton Township (*R. Hull*)—Middle or Marine Series of the Bowen River Coal Field.

*PRODUCTUS, sp. ind. (f.)*, Pl. 44, fig. 13.

*Obs.* A small form, which cannot be passed over, from the fact that the shell is preserved. It recalls to mind, in a very curious manner, the young condition of one of the varieties of the common *Productus giganteus* of the European Carboniferous rocks. The body of the shell is large and gibbous, as compared with the small and sharp ears, and transversely oblong in shape. The umbone is obtuse and much incurved, and the surface covered with fine, separate, thread-like direct ribs, and the small ears delicately wrinkled. In fact I never saw a closer resemblance in miniature to the above species than in this little shell.

*Loc. and Horizon.* Yatton Gold Field (*R. L. Jack*)—Gympie Beds.

\* Pal. Indica (Salt Range Fossils), 1884, Ser. xiii., Vol. i, Pt. 4, fas. 4, t. 74, f. 1-7.

† *Ibid.*, t. 74, f. 8a-d.

‡ Quart. Journ. Geol. Soc., 1862, xviii., p. 32, t. 2, f. 6.

*Genus—STROPHALOSIA, King, 1844.*

Ann. and Mag. Nat. Hist., 1844, xiv., p. 313; Mon. Permian Foss. England, 1850, p. 93.)

*STROPHALOSIA CLARKEI, Etheridge, sp.*

Pl. 13, figs. 12-17; Pl. 14, fig. 19.

- Productus Clarkei*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 334, t. 17, f. 2 and 2a-b, t. 18, f. 4-4a.  
 " " De Koninck, Foss. Pal. Nouv.-Gall. du Sud, 1877, Pt. 3, p. 203, t. 10, f. 5, t. 11, f. 2.  
 " " Etheridge fil., Cat. Australian Foss., 1878, p. 51.  
*Strophalosia Clarkei*, Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 289, t. 9, f. 18a-21, t. 10, f. 22-28, t. 11, f. 29-31, t. 12, f. 32 and 33.  
 " Woodsi, Davidson (ms.)

*Sp. Char.* Shell rotundate-quadrate, ventral valve strongly gibbous, or inflated; prominent and convex about the visceral region, sloping gradually off to the front, but non-geniculate and unproduced. Hinge-line straight, but not equal to the width of the shell. Ears flattened, small when compared with the general proportions of the valve. Beak large, short, and blunt, but not overhanging the hinge-line; immediately under it are two large, obliquely placed teeth, which fit into the sockets of the dorsal valve. In the umbonal region of the shell, proceeding from the beak towards the front, is a fine ridge or septum (a groove in casts) with, on each side of it, the dendritic adductor muscular impressions, each bounded on its outer margin by a well defined groove (ridges in the cast). Immediately in front of these adductor impressions is a large blunt prominence (which in the cast becomes a hole or fossa of varying depth, and of a very marked character), with the outer edge much less precipitous than the inner. On each side this prominence are the depressed scars of the cardinal muscles, much deeper and more impressed on their inner or umbonal margins, and gradually dying out laterally towards the sides of the valve; they are vertically grooved and ridged. (In the cast these impressions become ridged prominences, projecting or scarp-like along their upper edges, and they impinge somewhat on each side over the deep fossa just described.) The interior surface of the valve is pitted and ridged, producing, in the cast, granules and grooves; the former are continued over the surface of the blunt prominence (fossa in the cast); the ridges seen on the interior represent the decurrent bases of spines. The exterior surface is comparatively plain, with fine, vertical, wavy lines, projecting from which are occasional slender spines.

The dorsal valve is square, oval, flat, and very thick, bevelled outwardly from the interior on the front margin. The latter is apparently continuous, and not indented in any way. Hinge-line with rounded alar angles; area well marked, but not broad. Cardinal boss thick, strong, and prominent, projecting from the hinge-line at an angle of 119°, with the exterior plane of the valve centrally divided by a groove, which is flanked on each side by a kind of shoulder. Sockets for the reception of the teeth of the ventral valve, deep, broad, and so far surrounding the boss as to produce an appearance of isolation in the latter from the remainder of the valve. The cardinal boss is supported on each side by indistinct, oblique, alar ridges. Septum strong and ridge-like, extending for more than two-thirds the distance between the cardinal boss and the front margin, sometimes terminating in a small button. Immediately under the boss is a deep depression, divided in the middle line by the septum, and in which are situated the dendritic adductor muscular impressions. This depression is separated by a transverse ridge running across the valve from a second heart-shaped depression similarly divided by the septum. The reniform impressions are narrow, semilunar, much incurved, and abrupt at their front termination, and bounded outwardly by a deep groove or linear depression following their course. The internal bevelled edge is marked with very fine granules of pustules and small veinings, being the indications of



the vascular system. The shell has a silky appearance, and when weathered or decorticated, the shell-substance is marked by a series of fine, wavy, vertical lines. The valve is externally ornamented with a number of close, concentric, scaly laminæ and a few scattered spines similar to the ventral. A series of spines are also placed along the hinge of the ventral valve, erect, and graduating outwards from the umbo.

*Obs.* The history of *Strophalosia Clarkei* is a brief one. It was originally described by Mr. Etheridge as a *Productus*, from indifferent material in the Daintree Collection, and the external characters defined. Subsequently Prof. De Koninck placed under this name a shell in the W. B. Clarke Collection, and described it in his New South Wales Work. In my "Catalogue" I follow both these Authors in placing the species under the genus *Productus*, but had not then enjoyed an opportunity of examining specimens.

This interesting species, at the time my former description was written,\* was known under two conditions only—internal casts of the ventral valve, and dorsal valves retaining more or less of their shelly matter. More recently I have enjoyed the opportunity of examining no less than thirty-three excellently preserved specimens in the Mining and Geological Museum, Sydney, from New South Wales localities, several of which have the valves united. Nothing is brought more prominently forward by these specimens than the flatness and non-spinous condition of the dorsal valve, and herein, it appears to me, we have, in conjunction with the comparative absence of spines from the ventral valve, excellent specific characters for the separation of *S. Clarkei* from allied forms.

If we examine casts of the ventral valve, and compare them with the fine interior of *S. Goldfussi*, Münster, figured by the late Dr. Davidson,† it will be observed that in fig. 9, representing a cast in a similar state of preservation to our specimens, there is, as in the latter, the corresponding blunt and gradually attenuated but prominent beak (figs. 29 and 30,*i,i*),‡ and deep pits left by the teeth of the ventral valve (fig. 30,*a*). Again, compare, in fig. 10 of the "Permian Monograph," the concave or grooved back of the umbo with that of the Queensland cast (figs. 27-30,*b*). Thirdly, the position of the adductor scars in the same Permian figure is quite comparable with that of the Australian specimens (figs. 26-30,*c,c,c,c*). In Mr. Davidson's figure, the deep pit or fossa in front of these impressions is not so marked as in our fig. 29; but this is itself a variable point in the Australian shells. With regard to the cardinal muscular scars, we observe a perfectly similar arrangement—the position identically the same, similar ridging and grooving, the only apparent difference being that in the Permian *S. Goldfussi* the abrupt or scarp-like side appears to be towards the front, whereas in *S. Clarkei* it is towards the umbo or the hinge-line (figs. 27 and 29,*e,e,e,e*). It must, however, not be forgotten that all these characters are open to much variation in development, but not in feature, being very pronounced in some individuals, and feeble in others.

It is strange that, out of the large series obtained by my Colleague from the Bowen River Coal Field, so few specimens should retain traces of the septum, reniform impressions, and other anatomical details. The usual condition under which the dorsal valves of *S. Clarkei* are presented to us is shown by figs. 18*a*, 19, and 20, a flat, bevel-edged, more or less oval, silky shell, and, although viewed from the interior in each case, no trace of the marked characters of figs. 21 and 23 are visible, but on the contrary there is, in the place of the strong cardinal boss and septum, an oval gap in the shell

\* Proc. R. Phys. Soc. Edinb., 1880, v., p. 239.

† Mon. Brit. Permian Brach., t. 3, figs. 9-10.

‡ These numbers and letters refer to the figures given in my former description of *S. Clarkei* (Proc. R. Phys. Soc. Edinb., 1880, v.). (*R. E., Junr.*)

substance. This discrepancy between such examples as figs. 18a and 21 can be accounted for simply by decortication, because, on several specimens, traces of much shelly matter remain, which, if wholly preserved, would bring the shell up to the thickness required to make it correspond with fig. 21 or fig. 23.

The dorsal valve is invariably flat, or, at any rate, what little concavity there is, is simply a median depression. The surface is composed of scaly concentric laminæ, with wavy cross-lines and an occasional small spine. In specimens with the valves in apposition the relatively narrow and long area, as compared with that of the succeeding species, becomes very apparent.

In the Memoir on the Bowen River Coal Field fossils, three species of Australian *Strophalosia* were described, the present one, the succeeding species, *S. Gerardi*, and *S. Jukesii*. At that time much doubt existed as to the limitation of these species, but now, I believe, I am in a position to satisfactorily place all three on a firmer footing. The distinguishing features of *S. Clarkei* have already been pointed out; its relation to *S. Gerardi* will be shown under that species, but a few remarks on *S. Jukesii* may be made here.

The chief point relied on formerly for the separation of *S. Clarkei* from *S. Jukesii*, was the deltoid or sub-quadrate form of the latter, as compared with the broad oval outline of the former. It appears to me now that the internal characters of the dorsal valve afford a far better ground for separation. In *S. Clarkei* the septum extends almost the whole width of the dorsal valve, but in *S. Jukesii* it hardly does more than reach the middle of the valve. The deeply excavated cordate depressions on each side the septum of the former is absent in the latter. In the first-named species the renal impressions form together a broad oval curve, and terminate forwards in a line with the front end of the septum; in the second species, on the other hand, the renal scars are much more aurate, comparatively broader, but not so oval, and project towards the front far beyond the termination of the septum. These characters, when viewed together, present a very different appearance in the two species.

The original specimens on which I described *S. Jukesii* were said to have come both from New South Wales and Tasmania, but I believe this will prove a far more representative species of the latter than the former country.

*Loc. and Horizon.* Pelican Creek, Bowen River, five miles north of Sonoma Station; the same, opposite Palmer's Old Station; the same, three-quarters of a mile above Sonoma Road-crossing; Parrot Creek, Bowen River, four and a-half miles, eight miles, and nine miles up; Cockatoo Creek, Bowen River, half-a-mile above junction with Parrot Creek; Bowen River, two miles above Beasley's Old Public House (*R. L. Jack*); Springsure (*The late James Smith*)—Middle or Marine Series of the Bowen River Coal Field.

#### STROPHALOSIA GERARDI, *King*.

Pl. 13, fig. 18; Pl. 14, fig. 18; Pl. 40, figs. 7 and 8.

- Strophalosia Gerardi*, King, Ann. and Mag. Nat. Hist., 1846, xviii., p. 93.  
 , " De Koninck, Mon. Productus et Chonetes, 1847, p. 137.  
 , " King, Mon. Permian Foss. England, 1850, p. 96, t. 19, f. 6 and 7.  
 , " Davidson, Mon. Brit. Foss. Brach., Introduction, 1857, t. 8, f. 211.  
 , " Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 294, t. 12, f. 34-37, t. 13, f. 38.  
 , " Etheridge fil., Journ. R. Soc. N. S. Wales for 1883 [1884], xvii., p. 87.

*Sp. Char.* Shell of medium size, ovato-rotund, at times becoming almost deltoid, strongly concavo-convex. Ventral valve convex, most so about the umbonal and visceral regions; umbo prominent, rounded, and overhanging the area to some extent; area short, high, and triangular; dorsal valve varying from concave to semi-concave, following closely the contour of the ventral, assuming a more or less deltoid form, usually much

longer than wide; hinge-line variable in length but never as wide as the shell; area well marked, elongately triangular; deltidium conspicuous, convex; septum short; renal impressions broadly oval; internal surface highly granular. Surface of the ventral valve concentrically laminated, and giving rise to numerous adpressed tapering spines, which, when worn off, leave the valve covered by a series of short, blunt, somewhat projecting tubercles; surface of the dorsal valve similarly ornamented, but the concentric laminae appear to be smaller and closer together; near the front edge of the valve the lamellæ become very close and numerous, and assume a strongly imbricated appearance. The greatest concavity of the dorsal valve is just below or in front of the hinge-line, where it appears to become much pressed in. The shell at times assumes a slightly irregular aspect, with an inclination or oblique tendency towards one side or the other; the front margin is rounded and continuous, and shows no indication of an indentation or sinuosity.

*Obs.* The identity of this Indian species with shells from the Bowen River Coal Field was based on certain individuals from the latter, possessing, amongst other characters, very concave dorsal valves. This separation was made, to some extent, on the advice of the late Dr. Davidson, but it was hinted that perhaps the one might prove to be a variety of the other.\* The following remarks on this subject were made:—"Notwithstanding the flat valve of typical specimens of *S. Clarkei*, it is just possible that it and the shells now referred to *S. Gerardi*, with the concave dorsal valves, may after all be one and the same. . . . On the one hand we have a series of dorsal valves, all flat, and no ventral valve attached (= *S. Clarkei*); on the other hand, a number of bivalve examples, with very concave dorsal valves (?= *S. Gerardi*)."<sup>†</sup> It was subsequently shown, through specimens obtained by Prof. A. Liversidge from the Darr River,‡ that the two species were in all probability distinct, a point which I think now capable of proof. In contradistinction to *S. Clarkei*, the valves of *S. Gerardi* are both densely spined; the dorsal valve always very concave; the form more irregular in outline and smaller, the area wide, short, and triangular; spines long, pendent, and adpressed to the shell; and the surface of both valves very concentrically frilled; but particularly noticeable amongst these are the concave dorsal valves, and the short, high triangular area in the ventral valve.

The internal structure of the dorsal valve has always been wanting to complete the comparison, but this is now supplied by a Tasmanian specimen in the Australian Museum, which I believe to be this species. The broadly oval forms of the renal or vascular impressions resemble those of *S. Clarkei*, rather than *S. Jukesii*, whilst, on the contrary, the short septum indicates a resemblance to the latter. The deep depressions on each side the septum in *S. Clarkei* are quite absent, so is the transverse ridge separating the upper from the lower pair of these, and probably the support of the adductor muscles. The concavity of the dorsal valve varies, to some extent, in different individuals, but it is always very apparent. The hinge-line also varies in length, long in some examples, short in others, although, as before stated, it never extends the whole width of the shell.

It would appear, therefore, from the foregoing remarks that in the Permo Carboniferous rocks of this Continent and Tasmania, at least three species of *Strophalosia* are met with, as originally described by the Writer.

The resemblance of the Australian examples of *S. Gerardi* to Prof. King's Indian type is very marked, both in outward shape, nature of the spines, form of the dorsal valves, and the area.

\* Proc. R. Phys. Soc. Edinb., 1880, v., p. 295.

† Journ. R. Soc. N. S. Wales for 1883 [1884], xvii., p. 87.

‡ Locality doubtful. (*R.L.J.*)

*Loc. and Horizon.* Pelican Creek, Bowen River, five miles north of Sonoma Station; the same, opposite Palmer's Old Station; Parrot Creek, Bowen River, eight miles up; Bowen River, between Traverse Stations 25 and 26 (*R. L. Jack*); Banana Creek (*H. W. Mackay*; Colln. de Vis)—Middle or Marine Series, Bowen River Coal Field; "Darr River,\* about three hundred miles south-west of Port Denison" (*Prof. A. Liversidge*; Colln. Sydney University).

*Genus*—*CHONETES*, *Fischer*, 1837.

(*Oryctographie Gouv. Moscou.*, p. 134.)

*CHONETES CRACOWENSIS*, *Etheridge*, Pl. 13, fig. 9.

*Chonetes cracowensis*, *Etheridge*, *Quart. Journ. Geol. Soc.*, 1872, xxviii., Pt. 3, p. 336, t. 18, f. 2.

„ *Laguessiana*, *De Koninck*, *Foss. Pal. Nouv.-Galles du Sud*, 1877, Pt. 3, p. 207, t. 10, f. 7 (*excl. syn.*)

„ „ *Etheridge fil.*, *Cat. Australian Foss.*, 1878, p. 48.

*Sp. Char.* Shell transversely oblong or semicircular, wider than long, both valves ornamented with many ribs; hinge-line straight, not so long as the width of the shell; area narrow and parallel; ventral margin convex. Cardinal angles rounded and flattened at their extremities. Ventral valve slightly convex. Dorsal valve nearly flat, or following the curve of the ventral. Beak small, apparently slightly incurved, but not covering the hinge-line. The place of the hinge-spines faintly traceable. The surface of the shell covered by what must have been short and stout spines numerously distributed. (*Etheridge*.)

*Obs.* Mr. *Etheridge* considered that his species differed from the typical Carboniferous *Chonetes hardrensis* (= *C. laguessiana*), *De Koninck*, by possessing flatter cardinal angles, and many more spines. On the other hand, *Prof. De Koninck* united *C. cracowensis* with his *C. laguessiana*, and guided by his universally accepted high opinion, I followed a similar course in the "Catalogue of Australian Fossils." But an examination of numerous specimens from the Star River Beds causes me to doubt the advisability of this course, especially when Mr. *Etheridge's* figure, which excellently represents his species, is compared with that given by *Prof. De Koninck* of the shell from New South Wales. The figure of *C. cracowensis* represents a form with flat roundly rectangular sides, whereas the so-called *C. laguessiana* figured by *De Koninck* has acute cardinal angles, and the lateral margins rapidly and sharply merging into the ventral margins. I quite fail to see how two such differently shaped shells can be relegated to one species, and it will be better, in the meantime, to accept the name applied by Mr. *Etheridge* to this shell.

*Loc. and Horizon.* Cracow Creek, Dawson River, Lat. 25° 20' S., Long. 150° 15' E., approximate (*The late R. Daintree*)—Middle or Marine Series of the Bowen River Coal Field; Athelstane Range, Rockhampton (*The late James Smith*)—Gympie Beds; Corner Creek, Great Star River (*R. L. Jack*)—Star Beds.

*CHONETES, sp. ind. (a.)*, Pl. 13, fig. 10; Pl. 37, figs. 21 and 22.

*Obs.* A transversely semicircular, deep, and very convex, or, in fact, almost deltoid species, occurs in the Corner Creek Beds. It possesses the general form of *Chonetes polita*, *McCoy*,† but, unlike the latter, is strongly costate. The alar angles are pointed, and it is altogether an elegant little shell.

\* In this, as in the case of *Productus brachythærus*, I doubt the correctness of the locality quoted, as the Darr River is wholly in the Rolling Downs Beds. (*R.L.J.*)

† *Davidson*, *Mon. Brit. Carb. Brach.*, 1861, Pt. 4, p. 190, t. 47, f. 8-11.

In the Keelbottom River Series a somewhat similar shell is found, but less convex, and very strongly ribbed, with the hinge about equal in length to the shell. The ribs are coarse and bifurcate, about thirty-five previous to division, and irregularly rounded.

It is quite possible that both these shells are one species, but in the presence of the immense number of *Chonetes* already described, it is impossible to venture on a name, especially when dealing with imperfect material.

*Loc. and Horizon.* Corner Creek, Great Star River (*R. L. Jack*); Gully rising in cliff between two peaks on left bank of Keelbottom River, north of old Plum-tree Inn (*R. L. Jack*)—Star Beds.

*CHONETES, sp. ind. (b.)*, Pl. 13, figs. 7, 8, and 13.

[Compare *C. australis*, McCoy, Prod. Pal. Vict., Dec. iv., 1876, t. 35, fig. 1.]

*Obs.* The present *Chonetes* differs wholly from either of the preceding. The ventral valve is broad and semicircular, quadrate, deeper than wide, and very slightly convex. The hinge-line was as long as the shell, and when perfect the alar angles bluntly pointed, but, as a rule, they are broken. A moderately broad hinge appears to have been present, and there are the remains of several well-developed hinge-spines. There was a well-marked septum in both valves, and the inner surface highly pustulose, and punctate. The surface bore numerous distinct bifurcating ribs, and there is some indication of their having been spinose.

This species is probably closely allied to *Chonetes australis*, McCoy. It is certainly not *C. laquessiana*, as figured by De Koninck from New South Wales, and it does not appear to be a large form of *C. cracowensis*. It is also advisable to compare, in passing, *Chonetes falklandica*, Morris and Sharpe,\* with which there is again some resemblance. Except that it is a larger species, *C. illinoisensis*, Worthen,† would represent our shell, especially in the very large number of costæ. The latter are numerous, but less so than in *C. falklandica*, and coarser; they bifurcate high up on the visceral region, and are prominent and bold, although not coarse.

*Loc. and Horizon.* Athelstane Range, Rockhampton (*The late James Smith*); Stony Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

*CHONETES, sp. ind. (c.)*, Pl. 37, fig. 20.

*Obs.* A small, very flat shell, the ventral valve slightly elevated below the umbo, then depressed in the middle line, producing a broad and very flat sinus. The hinge-line as long as the shell, and the alar expansions also apparently flattened. The area is small, and the septum extends for about half the height of the valve. The ribs are very numerous and fine, and each one bifurcates; they must have been provided with regular concentric rows of spines, as the depressions representing the actual ribs are regularly so pitted. The lateral ribs are much curved outwards, whilst the umbo was very fine and small.

This pretty little cast at times looks more like an *Orthotetes* or *Streptorhynchus*, than a *Chonetes*. The tripartite division of the surface probably arises from a rather flatly prominent central region, and flattened alar expansions.

This is evidently not far removed from *Chonetes compressa* Waagen,‡ and, in fact, differs chiefly in the alar regions, being delicately striate, instead of quite plain. Waagen's remarks apply well to our specimens, bearing in mind that his examples were perfect, comparatively speaking, whilst ours are only impressions. He says—"This is a

\* Quart. Journ. Geol. Soc., 1846, ii., p. 274, t. 10, f. 4.

† Illinois Geol. Report, 1868, iii., t. 15, f. 8.

‡ Pal. Indica (Salt Range Fossils), 1884, Ser. xiii., Vol. i., No. 4, fasc. 4, p. 630, figs. a-d.

rather small species, with very flat valves, which are so close together that scarcely any room remains between them. The ventral valve bears, in the middle, a low sinus, and the radial striation of both valves is limited to the median parts, whilst the lateral parts remain entirely smooth."

*Loc. and Horizon.* Gully rising in cliff between two peaks on left bank of Keelbottom River, north of Old Plum-tree Inn (*R. L. Jack*)—Star Beds.

*CHONETES, sp. ind. (d.), Pl. 37, fig. 19.*

*Obs.* A somewhat large, elongately quadrate, convex, and high cast occurs in the fossiliferous masses of Mount Britton. There is a large wide area, deep sinus in the dorsal valve of casts, and at least four hinge-spines on each side the umbo. The front and sides are densely pitted, but the nature of the surface is unknown.

This form is only known to me as casts, but probably, judging from its size, is allied to the Athelstane Range species (Pl. 13, fig. 8). The septum of the dorsal valve was large and strong. The cardinal muscular scars of the ventral valve were small and pear-shaped, and in this valve a septum also existed.

*Loc and Horizon.* Richards' Homestead, three miles south-west of Mount Britton Township (*A. L. Morisset*)—Middle or Marine Series of the Bowen River Coal Field.

## Order—CLISTENTERATA.

### Family—LINGULIDÆ.

*Genus—LINGULA, Bruguière, 1791.*

(Encyclop. Méthod., i., Pl. 250, f. 1a-c.)

*LINGULA MYTILOIDES, J. Sowerby, ? Pl. 13, fig. 19.*

*Lingula mytiloides, J. Sby., Min. Con., 1813, i., p. 55, t. 19, f. 1 and 2.*

„ *mytiloides, Davidson, Mon. Brit. Carb. Brach., 1861, Pt. 4, p. 207, t. 48, f. 29-36.*

*Obs.* Except that the specimen referred to this species is rather more angular along the middle line of the valve, it is difficult to distinguish it from typical examples of *L. mytiloides*. The test is preserved over half the surface of the specimen. Dana, in his Work on the Geology of the Wilkes Expedition, describes a species, *Lingula ovata*, which may perhaps also be the present shell. It is "quite small, much convex, regularly broad ovate, with the front margin not at all truncate. Beak acute, valves thin, smooth, with faint concentric lines of growth."

The genus *Lingula* is of so scarce an occurrence in Australian Permo-Carboniferous rocks that the present specimen is of some importance.

*Loc. and Horizon.* Spring Creek, Cania, Burnett (*W. H. Bands*)—Gympie Beds.

## Section—MOLLUSCA VERA.

### Class—PELECYPODA.

### Order—OSTRACEA.

### Family—PECTINIDÆ.

*Genus—ENTOLIUM, Meek, 1872.\**

(Hayden's Final Report E. Nebraska, p. 189.)

*Obs.* The existence of this, as an Australian genus, depends upon a few small and ill-preserved specimens in the Star River collections, made by my Colleague, and

\* Prof. James Hall says—"Pal. California, 1864, i., App. B., p. 478," and that *Entolium* in its Palæozoic sense is but a synonym of *Pernopecten*, Winchell. See *Pal. N. York, 1885, v., Pt. 1, No. 2, p. lvi.*

resembling the characteristic British species *E. Sowerbii*, McCoy, sp. One specimen showed the concentric close ornament, and seems to be the valve with the conate ears; another displays the interior of the flat-eared valve (Pl. 14, fig. 10), and, above all points, the typical central cartilage pit, the sockets for the obliquely diverging ridges, and the long posterior lateral grooves; and there is a trace of the large eccentric adductor muscular impression.

These Corner Creek specimens are small, but bear no comparison with the *E. Sowerbii*; it is therefore, probably, a distinct and smaller species, but the material is not copious enough to permit of a satisfactory determination.

*Loc. and Horizon.* Corner Creek, Great Star River (*R. L. Jack*)—Star Beds.

*Genus*—*EUCHONDRIA*, Meek, 1874.

(*American Journ. Sci.*, 1874, vii., pp. 445 and 488.)

*Obs.* In this genus of Pectenoid shells, the hinge structure is peculiar. There is a "comparatively large, oblique, central cartilage pit, and a row of smaller ones crossing the area at right angles all along, both before and behind the large oblique central pit."

The above are the late Professor F. B. Meek's remarks in establishing his genus for the little *Pecten neglectus*, Geinitz, from Illinois. He believed *Euchondria* to be more nearly allied to *Pernopecten*, Winchell,\* than to *Aviculopecten*, but differs from the former in the obliquity of the central cartilage pit, and the presence of the true cartilage pits along the hinge. The so-called cartilage pits along the hinge of *Pernopecten* are probably only interlocking crenulations of the hinge, and not receptacles for any portion of the ligament.

Amongst the many indistinct fossils from the Corner Creek Beds, was a small semicircular shell with close, fine, concentric striæ, a very rounded ventral margin, a long hinge-line, and a small anterior ear with radiating ridges. Along the latter are faintly visible the impressions of a vertical series of hinge-pits resembling those of *Euchondria*. No central oblique pit was observed, however, and since the specimen has passed from my hands, it has struck me that the genus *Crenipecten*, Hall,† might put in as good a claim for it as *Euchondria*. In Hall's genus the "hinge is furnished with a series of small cartilage pits throughout its entire length"; and it would not surprise me to find that the impression under discussion is more properly referable to this than to the genus to which I assigned it in the list originally forwarded to my Colleague.‡

*Loc. and Horizon.* Corner Creek, Great Star River (*R. L. Jack*)—Star Beds.

*Family*—*AVICULOPECTINIDÆ*.§

*Genus*—*AVICULOPECTEN*, McCoy, 1851.

(*Ann. and Mag. Nat. Hist.*, 1851, vii., p. 171.)

*Obs.* In the Corner Creek Beds, three species of *Aviculopecten* have been noticed. In the first species the hinge-line is long, the surface covered with fine radiating costæ, and the anterior ear very pronounced, narrow, long, and triangular, with

\* As a matter of fact it is more nearly allied to *Crenipecten*, Hall.

† Prelim. Notice Lamellib. Shells, Up. Helderberg, Hamilton and Chemung Groups, Pt. 1, 1884, p. 406b.

‡ Handbook Queensland Geol., 1886, p. 39.

§ Meek and Hayden, Pal. Up. Missouri, 1865, Pt. i., p. 49

three or four strong diverging ridges. The second species is highly cancellate, the radiating costæ being fine, close, and round. The third shell is very small, and indicates a triangular species very narrow towards the umbones, and widening ventrally. No ornament is preserved, and only one of the anterior ears, which is triangular and deeply divided from the body of the shell. The whole of these points are such common characters amongst this group of shells, that they cannot be alone used for specific differentiation.

Mr. Rands has collected from Banana Creek, near Rockhampton, what is obviously another fragment of an *Aviculopecten*. It is a fragment without ears or hinge-line, covered with fine, elevated, radiating striæ, slightly curved towards the sides of the shell, and with an intermediate rib between each pair; the whole are crossed by equidistant regular concentric lines, forming, by their intersections, small quadrangular spaces.

*AVICULOPECTEN SUBQUINQUELINEATUS*, McCoy, sp.

*Pecten comptus*, Dana (non McCoy), American Journ. Sci., 1847, iv., p. 160.

„ *subquiquelineatus*, McCoy, Ann. and Mag. Nat. Hist., 1847, xx., p. 298, t. 17, f. 1.

„ *comptus*, Dana, Geology Wilkes' U. S. Explor. Exped., 1849, Vol. x., p. 704, Atlas, t. 9, f. 5.

„ *subquiquelineatus*, McCoy, Proc. R. Soc. V. D. Land, 1851, i., p. 322, t. 17, f. 1.

*Aviculopecten subquiquelineatus*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 295, t. 22, f. 2

„ „ Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 297, t. 15, f. 52.

*Obs.* This is a large, strong, and distinctly marked species, at first sight resembling *A. Fittoni*, Morris,\* but easily distinguishable from it by the plain and entire condition of the radiating costæ; whereas in *A. Fittoni* the latter are composed of a series of smaller radii. In both species the valleys between the ribs are filled with subordinate costæ. In Morris's species there is only one between each pair of ribs, but in McCoy's there are from three to five. In *A. subquiquelineatus* the ears are large and radiately striated, and the whole shell must have grown to some considerable size. It appears Professor Dana's name of *P. comptus* has precedence of McCoy's by a short time, and would be the accepted one for this species, were it not that the name *comptus* had already been used by Professor McCoy † for an Irish Carboniferous Limestone shell. Professor Dana's name has therefore to give way to the subsequently described *P. subquiquelineatus*.

*Loc. and Horizon.* Bowen River, at No. 25 Traverse Station (*R. L. Jack*), in a hard flinty micaceous sandstone of the Middle or Marine Series, Bowen River Coal Field.

*AVICULOPECTEN LIMIFORMIS*, Morris, ? Pl. 14, fig. 1.

*Pecten limiformis*, Morris in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 277, t. 13, f. 1.

*Aviculopecten limiformis*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 291, t. 22, f. 4.

„ *sp. ind.*, Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 298.

*Obs.* A single specimen of a large species of *Aviculopecten*, with portions of the valves in apposition, has been obtained by my Colleague. It is a mere cast with remains of shelly matter here and there, but appears to correspond to a great extent with *A. limiformis*, Morris.‡ The shell is very inequivalve, one valve being moderately convex, the other almost flat, or even, towards the ventral margin, a little concave. These characters would accord better with those of the species mentioned, than with any other of the Australian forms so far as described to the present time. In the Daintree Collection, Mr. Etheridge determined the presence of this shell and gave the following

\* Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 14, f. 2.

† Synop. Carb. Limest. Foss. Ireland, 1844, p. 90, t. 15, f. 14.

‡ Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 277, t. 13, fig. 1.



diagnosis \* :—"Shell inequilateral or oblique, slightly convex near the umbonal region or beak; the ribs are also irregular and wavy, about thirty-five in number, and all meet near the umbo; lines of growth obscurely wrinkled; ears small, radiated, and coarsely wrinkled. Prof. Morris does not state the dimensions of his shell; proportionately our single specimen agrees with his, but apparently is individually larger."

The general obliquity of the valve, and the convexity in the umbonal region, certainly point to this species, but the anterior ear, well relieved from the body of the shell, does not accord at all with Morris's figure, nor is there any indication of this in De Koninck's illustration. I must confess to never having seen a complete individual of this species, and I am therefore rather in the dark as to its true appearance; but the obliquity, and the great inequality of the valves, as expressed above, are certainly important characters.

I now figure a rather similar *Aviculopecten* (Pl. 14, fig. 1) from Gympie, in which the anterior ear is similar in shape to that of Mr. Etheridge's figure, but is less detached from the shell. This, for the present, must be regarded as referable to *A. limæformis*.

It is so rare to obtain any of these Australian *Aviculopectens* with the true shell remaining that identification in such a case, especially with mutilated examples, becomes difficult. Such a specimen has been obtained in the Yatton Gold Field, but space does not permit of our figuring it. The valves are in apposition, and portions of the ears wanting. The larger valve is oval and decidedly convex, the smaller convex in the visceral region, but gradually becoming flat, or even concave towards the front margin, and to some extent also, the sides. In these we trace decided *A. limæformis* characters. Both valves possess about twenty-four broad, rather flattened ribs, those of the one valve fitting into those of the other at the ventral margin, and causing the latter to become fluctuating. Corresponding interspaces exist crossed by very close projecting frills. One end of the shell (it is difficult to say which, the ears being removed) is convex in the larger valve, but sublobate in the flat or concave piece, another character of *A. limæformis*.

Until the entire appearance of the last-named is more familiar, the identity of these species must remain open, but if not *A. limæformis*, it is possible that the present form, and Mr. Etheridge's figured specimen, may form a separate species, as they appear to have several points in common.

*Loc. and Horizon.* Coral Creek, Bowen River, below Sonoma Road-crossing (*R. L. Jack*)—Middle or Marine Series, Bowen River Coal Field; ? Gympie (*R. L. Jack*)—Gympie Beds; ? Yatton Gold Field (*R. L. Jack*)—Gympie Beds.

#### AVICULOPECTEN ? IMBRICATUS, *Etheridge*.

*Aviculopecten ? imbricatus*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., Pt. 3, p. 326, t. 14, f. 2.

" " Etheridge fl., Cat. Australian Foss., 1878, p. 6.

*Sp. Char.* Shell inequilateral, and possessing twenty-two ribs, the ends or extremities of which imbricate or overlap in the cast; there appears to be, or to have been, a space between the end of each rib at its extremity, or along the ventral margin; faint longitudinal markings run down each of the ribs, following their course. (*Etheridge*.)

*Obs.* An impression only occurs, and that of the inner surface, of one valve of this singular and doubtful shell. Our figure is taken from a gutta-percha cast of the impression left. That it belongs to the Asiphonida I do not doubt, and, I believe,

\* Quart. Journ. Geol. Soc., 1872, xxviii., p. 326, t. 14, f. 1. I am much puzzled by the central oval impression on the umbonal region. It cannot be a cartilage pit of the hinge, as it is in the wrong position for such a structure. (*R. E., jun.*)

to one of the *Aviculidæ*. The umbonal region is certainly not complete; and, therefore, no true conclusion can be arrived at relative to the nature of the ears and hinge-line of the perfect shell. (*Etheridge*.)

*Loc. and Horizon.* Gympie (*The late R. Daintree*)—Gympie Beds.

#### AVICULOPECTEN MULTIRADIATUS, *Etheridge*.

*Aviculopecten multiradiatus*, *Etheridge*, Quart. Journ. Geol. Soc., 1872, xxviii, p. 327, t. 13, f. 1.

*Sp. Char.* Shell nearly equilateral, orbicular, depressed, slightly convex, with about sixty well-defined equidistant sharp ribs, all meeting at the umbo; these ribs appear to have been sharply elevated and plain; ears not seen; lines of growth well defined. (*Etheridge*.)

*Obs.* *Aviculopecten multiradiatus* was compared by Mr. *Etheridge* to *A. planoradiatus*, McCoy, and *A. docens*, McCoy, both species of the British Carboniferous Limestone. It differs from the first in being less convex, but appears to be a more robust shell than the latter. The Author likewise added—"It has also affinity with *Pecten squamiferus*, Morris, from Mount Wellington, Van Diemen's Land.\* I cannot, however, clearly determine the presence of imbricated scales upon the ribs." Unfortunately, in the figure accompanying these remarks, the indications of scales on the ribs are distinctly visible, and it is exceedingly probable that the shell is only, after all, *Aviculopecten squamiferus*, Morris.

*Loc. and Horizon.* Gympie (*The late R. Daintree*)—Gympie Beds. An *Aviculopecten* like this species also occurs at Kooingal (*The late James Smith*)—Gympie Beds.

#### AVICULOPECTEN LAURIENTI, *sp. nov.*, Pl. 43, figs. 3 and 4.

*Sp. Char.* Shell small, orbicular, sub-equilateral, anterior, posterior and ventral margins rounded; umbones small, moderately acute. Right valve hardly convex, much flattened; anterior ear elongately triangular, narrow, separated by a long, deep, and narrow byssal sinus; posterior ear small, more or less rectangular; surface smooth, or with a few concentric growth-marks; ears apparently smooth. Left valve slightly convex, with a straight hinge-line, rather less than the width of the shell, squarish; anterior ear small, triangular, posterior small but wing-like; anterior ear and body of the valve covered with a large number of very fine radiating costæ and interpolated riblets, crossed by equally fine concentric decussating laminæ, and especially well marked on the anterior ear.

*Obs.* It is impossible to admit the shell De Koninck has called *Aviculopecten depilis*,† to McCoy's species of the same name. It is probable that the present shell is that referred to by the former under that designation. In *A. depilis*, McCoy,‡ the anterior ear of the right valve is squarish, not particularly elongated, and but little separated from the shell. In the present species it is quite the opposite of this. Had these characters been applicable to the left, instead of the right valves, a very close resemblance would have existed between the fossils now before me and *A. variabilis*, McCoy.§ On the whole I think it will be better to separate them under the above name rather than admit a doubtful reference to a little known European species. I name this in memory of Prof. L. G. De Koninck.

\* Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 278, t. 14, f. 1.

† Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, t. 22, f. 7.

‡ Synop. Carb. Limest. Foss. Ireland, 1844, t. 16, f. 11.

§ *Ibid.*, t. 1, f. 7.

*Loc. and Horizon.* West of the Dividing Range, at the Crow's Nest, Mount Victoria, near Mount Morgan (*The late James Smith*; Mining and Geol. Mus., Sydney); Rockhampton District\* (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

*Genus*—*DELTOPECTEN*, *gen. nov.*

*Gen. Char.* Shell possessing the general structure of *Aviculopecten*, but the valves very inequivalve, the larger or convex valve with a high overcurved umbo, overhanging a long triangular hinge area, with longitudinal cartilage furrows, and a large deltoid-triangular cartilage pit.

*Obs.* *Deltopecten* is intermediate in its structure between *Pecten* and *Aviculopecten*. It possesses the central cartilage pit of the former, and the furrowed area of the latter, and besides this the larger or convex valve is much higher than its neighbour, the umbo of the one overhanging that of the other, similar to the structure of the genus *Janira*. It may therefore be said to be a compound of the structure of all three genera. This so thoroughly departs from the structure of *Aviculopecten*, and is, further, such an additional modification of the hinge structure in this group of shells, to that indicated of late by various American Authors, that it seems to me to be worthy of generic distinction. I therefore propose for the following Australian species, the only one in which I have as yet noticed this structure, the name *Deltopecten*, in allusion to the shape of the cartilage pit or depression occupying the hinge area.

*Type.* *Pecten illawarensis*, Morris.

*DELTOPECTEN ILLAWARENSIS*, Morris, sp., Pl. 41, fig. 3; Pl. 43, fig. 2.

*Pecten illawarensis*, Morris in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 277, t. 14, f. 3.

" " Dana, Geology Wilkes' U. S. Explor. Exped., Vol. x., 1849, p. 705, Atlas, t. 9, f. 9.

*Aviculopecten illawarensis*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, Pt. 3, 1877, p. 301, t. 22, f. 1.

*Obs.* Prof. De Koninck has correctly described this shell as inequivalve, even allowing for the fact that nearly all shells of this group are more or less so. The larger valve is very much the more convex of the two, and better developed, with a large and high umbo overhanging the hinge area. These points are well shown in De Koninck's figures. The area is exceedingly broad and strong, especially beneath the umbones, where it is excavated into a pseudo-cartilage pit of a deltoid or roundly triangular form, the area gradually narrowing outwards towards the anterior and posterior extremities. The pit must have been the receptacle for a large and strong cartilage. The whole area is coarsely transversely striated, or grooved.

The radiating costæ of the surface vary to some extent in number. In Prof. Morris's figure, which appears to be that of the smaller valve, there are twelve or thirteen ribs, in that given by De Koninck of the same valve fifteen, whilst his view of the convex valve exhibits still more, perhaps twenty. In our specimens, the average number appears to be about fourteen.

The depression of the valves towards the front margins, referred to by De Koninck, takes place between the edges and the pallial impression, which is a well-marked feature in the examples before me.

In Professor James Hall's figure of *Aviculopecten princeps*, Conrad, sp.,† there is both a triangular area, and a central depression. The former is very apparent,

\* See note, p. 199.

† Prelim. Notice Lamellib. Shells, Up. Helderberg, Hamilton and Chemung Groups, Pt. 1, 1884, t. 2, f. 4.

but the latter is but indistinctly outlined. It is possible that a re-examination of this species, with the light thrown by *D. illawarensis*, may show a closer relation between the two.

*Loc. and Horizon.* Richards' Homestead, three miles south-west of Mount Britton Township (*R. Hull*)—Middle or Marine Series, Bowen River Coal Field.

*Genus*—*PTERINOPECTEN*, Hall, 1884.

*Pterinopecten*, Hall, Pal. N. York, 1884, v., Pt. i., No. 1, p. xii.

„ 35th Ann. Report, Regents Univ. State Cab. N. York, 1884, p. 406b.

*Gen. Char.* General characters of *Aviculopecten*, but the hinge-line long. Ears not well defined, being simple expansions or extensions of the upper lateral margins to the hinge-line. Test ornamented with rays. (*Hall*.)

*Obs.* Prof. Hall is, I believe, quite correct in separating from *Aviculopecten* those forms in which the ears are ill-defined, and not cut off from the body of the shell, especially the anterior one, except in one valve, as is usually the case in the typical species of that genus. This is accompanied by a posterior obliquity of the shell, which is equally characteristic. I have not Sowerby's "Mineral Conchology" to refer to, but if memory does not deceive me, *Pecten papyraceus*, Sby., of the English Coal Measures, will fall into this genus. Perhaps also *Aviculopecten nodulosus*, De Koninck,\* will form another species.

*PTERINOPECTEN DEVISII*, *sp. nov.*, Pl. 40, fig. 9.

*Sp. Char.* Shell of medium size, obliquely rhomboidal, the length and height being nearly equal, but the greatest length a little below the middle. Anterior and ventral margins regularly rounded, but the posterior margin sigmoidally curved. Hinge-line straight, a little shorter than the length of the shell. Umbonal region more or less flattened; beaks inconspicuous, anterior. Anterior ears small, triangular, separated by an undefined sulcus; posterior ears flattened, margins concave, and their extremities pointed. Surface of the left valve with moderately strong, direct, and non-flexuous radiating costæ, becoming much finer on the posterior ears, those on the body of the shell, at least, bifurcating, perhaps all; concentric lines of growth wide apart.

*Obs.* There is a strong resemblance between all the species of this genus, and it is at times difficult to differentiate between them. The present species is, however, a marked one, from the relative resemblance between the height and length. In general outline *P. Devisii* approaches very closely the British Coal Measures species, *P. papyraceus*, Sby., *sp.*, but is more coarsely ribbed. In outline there is a marked correspondence with *P. hoosacensis*, Wallcott,† but a similar difference exists here, in addition to the fact that the ribs are less numerous. In the extensive height of its valves, our species is also very like *P. erectus*, Hall, of the Chemung Group of North America.

It is named in honour of Mr. C. W. De Vis, M.A., Curator of the Queensland Museum, to whom I am indebted for numerous contributions of specimens for the illustration of the present Work.

Another specimen, from the same Collection, with the umbones and hinge-line wanting, closely resembles the type specimen in general appearance, but the radiating costæ are much finer, and far more numerous. They are also nodulated, but whether

\* Faune Calc. Carb. Belg., 1885, Pt. 5, t. 37, f. 6.

† Mon. U. S. Geol. Survey (Pal. Eureka District), 1884, viii., p. 232, t. 8, f. 9.

independently, or as arising from the passage of concentric laminæ, it is impossible to say. It is, of course, conceivable that this may represent a distinct species resembling very closely the British *P. papyraceus*.

*Loc. and Horizon.* Rockhampton District \* (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

## Order—MYTILACEA.

### Family—AVICULIDÆ.

#### *Genus*—MERISMOPTERIA,† *gen. nov.*

*Gen. Char.* Pteronitiform in appearance, the anterior end lobe-like and well developed; posterior end alate. Area excavated along the cardinal edge of both valves, and deeply ridged for the reception of a ligament; cardinal teeth wanting, but a strong clavicle descends in each valve before the anterior adductor muscles; one or more lateral teeth in each valve. Anterior muscular scars double and strong, the superior scar situated towards the umbones. External ornament of concentric ridges.

*Obs.* Those acquainted with *Pterinea* will at once perceive that the shell so generally known to Australian Palæontologists as *Pterinea macroptera* cannot properly be referred to that genus, from the character of its hinge. In *Pterinea* there are well-defined cardinal teeth, anterior in position to the umbones, and one or more posterior, lateral, oblique teeth, besides a striated or grooved hinge-margin, and a well-developed posterior muscular scar. In the proposed new genus, there are no cardinal teeth proper, one lateral tooth only, either oblique or horizontal, and, further, the posterior scar is very indistinctly developed. But, proceeding from the cardinal margin, and anterior to, and bounding the anterior scar, is a very strong clavicle or crest, leaving very deep slits in casts. Herein the structure of this shell differs very widely from that of *Pterinea*. The hinge area of each valve is large, high, and coarsely ridged, and when the valves are in apposition, forming a deep angular and elongated depression, which, during life, must have been filled by a strong and powerful ligament.

These features are particularly well shown in Morris's figure of *P. macroptera*, especially the clavicle and the posterior lateral tooth. In Prof. De Koninck's figure, on the other hand, the anterior scar is placed before the clavicle, a very erroneous representation, as it succeeds immediately after it, and is supplemented by a very prominent, but at the same time smaller scar above it towards the umbones, but still not within the beak cavity; this scar is not shown in De Koninck's figure at all.

*Type.* *Pterinea macroptera*, Morris.

#### MERISMOPTERIA MACROPTERA, *Morris*, sp.

*Pterinea macroptera*, Morris in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 276, t. 13, f. 1 and 2.

" " De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 305.

" " Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 298.

*Obs.* My Colleague has obtained a *Pterinea*, clearly this species, but only one specimen, and that without a part of the posterior wing. The small anterior lobe is only partially preserved; the hinge-line was clearly somewhat less than the width of the shell; and there are distinct remains of concentric laminæ, although the specimen is only a cast. The cast of one of the characteristic teeth is also preserved.

*Loc. and Horizon.* Coral Creek, below Sonoma Road-crossing, Bowen River (*R. L. Jack*)—in decomposed nodular ironstone of the Middle or Marine Series of the Bowen River Coal Field.

\* See note, p. 199.

† μερισμός = a partition.

## Family—MYTILIDÆ.

Genus—*MYTILOPS*, Hall, 1884.\*

(Pal. N. York, v., Pt. 1, No. 1, p. xiv.)

*MYTILOPS* ? *CORRUGATA*, *sp. nov.*, Pl. 40, fig. 11.

*Sp. Char.* Shell obliquely mytiliform, triangular, produced more or less posteriorly and ventrally. Dorsal or cardinal margin short and straight, not obliquely elevated; ventral margin oblique, longer than the cardinal margin; anterior end small, somewhat puckered; posterior margin obliquely truncated. Beaks terminal. Surface with from twelve to twenty step-like imbricating flattened and concentric ridges, non-striate, and graduating upwards to the umbones. Diagonal ridge broadly convex.

*Obs.* This is a small shell, much resembling in its surface markings McCoy's *Pullastra* ? *striatocostata*,† except that it is oblique, the hinge-line short, and the concentric costæ plain. In the latter, which has been figured by De Koninck ‡ as *Edmondia* ? *striatocostata*, the dorsal and ventral margins are parallel, and the ends elliptically rounded. Here both are very oblique. The external markings give the present shell a very noticeable appearance. I have not seen the nature of the hinge, but it corresponds with the external characters of the shells named *Mytilops* by Prof. James Hall. There is some resemblance between *Avicula Hardii*, De Koninck, and the present species, but the latter is a much deeper shell.

*Loc. and Horizon.* Rockhampton District § (*C. W. De Vis*; Colln. de Vis)—Gympie Beds.

*MYTILOPS* ?, *sp. ind.*, Pl. 14, fig. 20.[Compare *Mytilus Bigsbyi*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, t. 21, f. 1.]

*Obs.* The shells described by De Koninck from New South Wales will probably fall within Hall's genus *Mytilops*. The present form is neither so thick nor yet so transversely expanded as this species, otherwise it appears to be very near it. Only two examples have come before me, both much compressed, and one imperfect. The nature of the interior of the shell is unknown.

*Loc. and Horizon.* Gympie (*R. L. Jack*)—Gympie Beds.

Genus—*MODIOMORPHA*, Hall and Whitfield, 1869.

(Prelim. Notice Lamellibranc Shells, p. 72.)

*MODIOMORPHA* ? *DAINTREEI*, *sp. nov.*, Pl. 14, fig. 13.

*Sp. Char.* Shell transverse, elongately triangular, or irregularly subobovate, narrowed anteriorly, expanded posteriorly; probably thin-shelled; a narrow ill-defined sinus proceeds from the umbones to the ventral margin, immediately at the anterior end. Hinge long but not extending the whole length of the shell, rising slightly posteriorly; ventral margin straight at the anterior end, rather curved posteriorly. Anterior end small, lobate, posterior end subulate; margin obliquely truncated. Anterior muscular scars small, close under the umbones; beaks moderately acute; valves convex, with strong diagonal ridges, the surface between them and the hinge more or less concave; ornament unknown.

\* This genus may have been proposed at an earlier date, but it is very difficult to get at the real dates of a large number of Prof. Hall's genera, his system of publication being, to say the least of it, a very complicated one. The above is the first reference I am acquainted with. (*R. E. Junr.*)

† Ann. and Mag. Nat. Hist., 1847, xx., p. 305, t. 14, f. 3.

‡ Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 269, t. 18, f. 3.

§ See note, p. 199.

*Obs.* The present shell appears to correspond in general outline with those American Bivalves for which Prof. James Hall and Mr. Whitfield have proposed the above genus. There is, however, a less arcuate outline, and a more determinate diagonal ridge. The concavity above the latter is a very marked feature in this species. Furthermore, I have not seen "the single strong wedge-form tooth in the left valve, and corresponding cavity in the right," which appears to distinguish *Modiomorpha*.

One specimen seems to show indications of some radiating ribs on the body of the shell, parallel to the diagonal ridges, but they are very indistinctly preserved.

*Loc. and Horizon.* Hawkins' Gully, Kroombit Diggings, Port Curtis (*W. H. Rands*)—Gympie Beds.

*MODIOMORPHA MYTILIFORMIS*, *sp. nov.*, Pl. 14, fig. 5; Pl. 40, fig. 4.

*Sp. Char.* Shell transversely ovate, modioliform, convex, curved, moderately gibbous, expanding posteriorly, dorsal and ventral margins divergent. Anterior end small but non-lobate, its margin rounded. Posterior end expanded, gradually compressed, the convexly rounded margin gradually passing imperceptibly into the dorsal margin, the widest portion of the curve being above; ventral margin concave centrally, convex anteriorly and posteriorly; cardinal or dorsal margin elevated, nearly straight but not in the least angulated; hinge-line of the left valve with a long socket under the beaks for the reception of tooth of the opposite valve, and a long posterior lateral tooth; valves convex medially, a broad and rounded diagonal ridge proceeding from the beaks and becoming lost towards the posterior end. Umbones small and quite anterior, an almost imperceptible sinus running from them in each valve, to the ventral margins. Surface with broad concentric folds.

*Obs.* This shell is very like the smaller figure of McCoy's *Modiola crassissima*,\* but not the larger one, and may even be the latter. But in the present shell there is no angulation of the posterior hinge-line, this and the posterior margin insensibly passing into one another. Again, there is little or no sulcus from the umbones towards the ventral margin, the sinuation of the latter being much more gradual in the present shell, and placed nearer the centre of the margin, with a corresponding decrease in height of the posterior end. To some extent *M. mytiliformis* resembles *Cypricardia imbricata*, Dana,† but in the figure of the latter the ventral margin is not at all inflected, and there does not appear to be any umbonal slope. Furthermore, the posterior end, judging by the surface ornament, was sigmoidal. In Pl. 38, figs. 12 and 13, is probably represented the younger condition of this species, which is equally like Dana's *Cypricardia prærupta*,‡ but the cardinal margin of the latter is too horizontal; and again there is an entire absence of the diagonal convexity visible in our little shell.

The young form (Pl. 38, figs. 12 and 13) again might at times be mistaken for Dana's *Cypricardia simplex*,§ but the same points will serve to separate the two. The name *Cypricardia* is merely quoted from Dana, as it is most inappropriate to these shells.

*Loc. and Horizon.* Banana Creek, Banana, Dawson River (*R. L. Jack* and *C. W. De Vis*); Richards' Homestead, three miles south-west of Mount Britton Township (*R. Hull*)—Middle or Marine Series, Bowen River Coal Field.

\* Ann. and Mag. Nat. Hist., 1847, xx., p. 300, t. 15, f. 2 and 3.

† Geology Wilkes' U. S. Explor. Exped., Vol. x., Atlas, t. 8, f. 5.

‡ *Ibid.*, f. 10.

§ *Ibid.*, t. 9, f. 2.

## Order—ARCACEA.

## Family—ARCIDÆ.

Genus—*PARALLELODON*, Meek and Worthen, 1866.\*

(Proc. Chicago Acad., i., p. 17.)

*PARALLELODON COSTELLATA*, McCoy, Pl. 40, figs. 12 and 13.*Byssarca costellata*, McCoy, Synop. Carb. Lime. Foss. Ireland, 1844, p. 72, t. 11, f. 36.*Palæarca costellata*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 286, t. 16, f. 6 and 7.

*Sp. Char.* Shell small, subrhomboidal, rather square-ended, valves fairly convex, about twice as long as wide. Anterior end short, rather alate, the margin rounded, joining the hinge-line at a sharp angle; posterior end produced and compressed, the margin obliquely truncated, and rather emarginate. Dorsal margin straight, as long as the shell; ventral margin rounded, with a slight concavity a little anterior to the middle. Diagonal ridge pronounced but not acute, posterior slope rather concave, a sinus traversing the valves obliquely from the umbones to the concavity in the ventral margin. Posterior teeth three, long and rather oblique. Surface with concentric ridges at irregular intervals, close or distant, crossed by innumerable, fine, almost microscopic, radiating striæ, somewhat broken or fluctuating.

*Obs.* I am unable to compare this shell with McCoy's figure, and have to accept De Koninck's determination, but the above description will serve to show the trivial differences which exist between the present shell and the latter's description. These are the presence of the large number of radiating striæ, and three instead of two posterior teeth. In addition to these points the Queensland shell is much larger. Possibly it is a distinct species, and in that case may be known as *Parallelodon Konincki*.

*Loc. and Horizon.* Rockhampton District † (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

## Family—NUCULIDÆ.

Genus—*NUCULA*, Lamarck, 1799.

(Prodrome, p. 87.)

*NUCULA*, *sp. ind.*, Pl. 40, fig. 10.

*Obs.* A cast of a small oblong-deltoid shell, with a short posterior hinge, and a very abrupt, almost vertical, anterior margin. The anterior end is much reduced in size, and the beaks quite terminal; the posterior end is curved and produced. There are impressions of six hinge teeth, and traces of fine concentric striæ.

This fragment is so far satisfactory, that it demonstrates the presence of the genus in the Queensland beds. It properly belongs to the group of *Nucula tumida*, Phill. ‡

*Loc. and Horizon.* Rockhampton District § (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

\* *Macrodon*, Lycett, 1845, non J. Müller, 1842.

† See note, p. 199.

‡ Not to be confounded with *N. tumida*, Ten. Woods, a South Australian Tertiary Shell, which requires renaming.

§ See note, p. 199.



## Family—NUCULANIDÆ.

Genus—*NUCULANA*, Link, 1807.

(Besch. Natur. Samml. Rostok, iii., p. 155.)

*NUCULANA*, *sp. ind.*, Pl. 14, fig. 17.

*Obs.* A small specimen of a very inequilateral *Nuculana* represented by an external impression, after the type of *N. leiorhynchus*, McCoy,\* and *Nucula birostrata*, McCoy.† It possesses a snout-like posterior end. The anterior was moderately long, the umbonal region a good deal canted over to the posterior side, and high. The posterior end is sharply pointed, with a strong posterior angle, and the body of the shell delicately striate. It is absolutely impossible to distinguish between the present shell and an undetermined Carboniferous *Nuculana* figured by Messrs. Meek and Worthen but not described.‡ Our specimen corresponds in every particular, even to size, and although the material is too little to found a species on, I would beg to suggest that in the event of further specimens showing the Queensland shell constant, that it and the American species be called *Nuculana Wortheni*.

*Loc. and Horizon.* Corner Creek, Great Star River (*R. L. Jack*)—Star Beds.

## Order—LUCINACEA.

## Family—SOLEMYIDÆ.

Genus—*SOLEMYA*, Lamarck, 1819.*Solemya*, Lamarck, Hist. Nat. Anim. sans Vert., 1819, v., p. 488.*Jancia*, King, Mon. Permian Foss. England, 1850, pp. 177 and 246.*SOLEMYA EDEL FELTI*, *sp. nov.*, Pl. 14, fig. 16.

*Sp. Char.* Shell narrow-oblong, length two and a quarter inches. Hinge-line not as long as the shell, a little angulated on the anterior side; beaks about one-third from the anterior end, apparently a little depressed. Anterior end small; posterior end elongated, possibly compressed; posterior slope small, and but slightly marked; posterior margin obliquely truncate. Surface with a large number of sharp, strong, radiating ribs, distributed over the whole, with a few transverse corrugations.

*Obs.* This fine species is a worthy addition to the limited number of *Solemya* known, and is named in compliment to the Collector.

In case it should at first sight be taken either for *Pleurophorus costatus*, Morris, or *P. Morrisii*, De Kon., it may be at once distinguished by having the whole surface radiate.

*Loc. and Horizon.* Stonehumpy Creek, Bowen River (*E. Edelfelt*)—Middle or Marine Series, Bowen River Coal Field.

## Family—ASTARTIDÆ.

Genus—*PLEUROPHORUS*, King, 1844.

(Ann. and Mag. Nat. Hist., xiv., p. 313.)

*PLEUROPHORUS RANDSI*, *sp. nov.*, Pl. 14, fig. 14.

*Sp. Char.* Shell oblong, moderately convex. Hinge-line straight and long; ventral margin gently convexly rounded. Anterior end small, posterior end flattened,

\* Synop. Carb. Lime. Foss. Ireland, 1844, t. xi, f. 27.

† Synop. Carb. Lime. Foss. Ireland, 1844, t. 11, f. 23.

‡ Illinois Geol. Report, 1873, v., t. 26, f. 10.

the margin obliquely curved downwards, posterior slope not manifest; siphonal ridge slightly perceptible. Umbones small, quite anterior, and from them proceed four diagonal ridges, spreading out ventrally: surface otherwise concentrically lined.

*Obs.* The above characters are taken from a decorticated cast. From *P. Morrisii*, De Koninck, this species differs by having diagonal ridges confined to the centre of the valve. From *P. biplex*, De Koninck, by possessing four instead of two diagonal ridges, as well as a much straighter hinge, and a different outline to the posterior margin. *P. Randsi* is undeniably nearest to the European *P. costatus*, Brown,\* but in the latter the divaricating ridges are broken up, three on the body of the shell and the fourth under the hinge-line.

*Loc. and Horizon.* Near Yarrol Station, Burnett (*W. H. Rands*)—Gympie Beds.

*Genus*—*ASTARTELLA*, Hall, 1858.†

(Iowa Geol. Report, Pt. 2, p. 715.)

*ASTARTELLA* ? *RHOMBOIDEA*, *sp. nov.*, Pl. 14, fig. 15.

*Sp. Char.* Shell small, square-ovate, compressed; hinge-line much arched, very oblique posteriorly; ventral margin rounded, anterior margin more inclined to be square than rounded, whilst the posterior margin is decidedly square; umbones prominent and projecting; lunule probably well marked; surface with sharp thread-like, raised, equidistant, concentric striae, with more or less flat interspaces.

*Obs.* The more important hinge characters of this shell are at present unknown, and its reference to *Astartella* is therefore purely suppositive. It possesses the sculpture of many species, but the hinge-line is too oblique for a true *Astartella*.

It agrees better generally with certain forms described by the late Dr. Meek from the Coal Measures of Ohio,‡ than it does with Hall's type, which is a more massive shell, although still small.

The sculpture of *A. ? rhomboidea* resembles that of *Pachydomus Danai*, De Koninck,§ but the shell otherwise differs completely in the outline of the posterior end. Again, it appears to have certain relations with the genus *Scaldia*, De Ryckholt, but the present name will, in the meantime, serve to distinguish it. It is certainly distinct from either of the New South Wales shells referred to this genus by Prof. De Koninck.

*Loc. and Horizon.* Gympie (*R. L. Jack*)—Gympie Beds.

*Genus*—*CYPRICARDELLA*, Hall, 1858.

*Cypricardella*, Hall, Trans. Albany Inst., 1858, iv., Pt. 1, p. 17.

*Microdon*, Conrad (non Agassiz), Journ. Acad. Nat. Sci. Philadelphia, 1842, viii., Pt. 2, p. 247.

*CYPRICARDELLA JACKII*, *sp. nov.*, Pl. 14, figs. 11 and 12.

*Sp. Char.* Shell oblong-ovate, moderately compressed, deeper than wide; hinge-line straight, horizontal; ventral margin very convexly rounded; anterior side small, the margin obliquely curved; posterior margin similarly curved, but not produced; umbones anterior, small, and inconspicuous; escutcheon well-marked and deep; lunule none, the anterior border being erect and simple; surface nearly smooth, or with very fine impressed concentric lines.

\* King, Mon. Permian Foss. England, 1850, t. 15, f. 13-20.

† Non *Astartella*, Dana, 1847.

‡ Ohio Geol. Report, 1875, ii., Pt. 2 (Pal.), t. 19, f. 1a and b.

§ Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 278, t. 19, f. 5.

*Obs.* The shell has undergone erosion about the umbones and dorsal margin, which gives it a rather inequivalve appearance. Its generic affinities are obscure, but it resembles several forms of *Cypricardella* lately described by Professor De Koninck. It is certainly undescribed as an Australian species.

*Loc. and Horizon.* Near Mount Hamilton, six miles north-east of Gympie (*R. L. Jack*)—Gympie Beds.

*Genus*—*ASTARTILA*, Dana, 1847.

(*American Journal Sci.*, iv., p. 155.)

*ASTARTILA CYTHEREA*, Dana, Pl. 14, figs. 3 and 4.

*Astartila cytherea*, Dana, *American Journ. Sci.*, 1847, iv., p. 155.

" " Dana, *Geology Wilkes' U. S. Explor. Exped.*, Vol. x., p. 690, Atlas, t. 4, f. 1-1g.

*Sp. Char.* Shell rhombic-ovate, sub-compressed. Hinge-line straight, ventral margin rounded, and moderately sharp at the gape. Anterior end rather acuminate produced, small, its margin sharply rounded; posterior end rounded, without emargination. Umbones quite anterior, and much incurved and elevated; a deep but not circumscribed lunule present. Surface very characteristically marked by regular flattened, non-imbricating, oblique, concentric laminæ, separated by shallow, narrow grooves, gathering together in bundles on the anterior end, and more or less striate.

*Obs.* The shell now under description approaches very closely, if it is not identical with, *Astartila cytherea*, Dana, which it resembles in general outline, the oblique hinge-line, and high and elevated incurved beaks. It also has a general resemblance to Morris's figure of a young individual of *Pachydomus globosus*,\* but the beaks are much smaller, and the anterior margin less defined and more excavated. It is, however, an open question if the figure quoted is a *Pachydomus* at all.

The present shell equally resembles *Pachydomus ovalis*, McCoy,† and it is even possible that this, and the shell referred to as figured in Dana's work, are identical.

*Loc. and Horizon.* Stonehumpy Creek, Bowen River (*E. Edelfelt*)—Middle or Marine Series, Bowen River Coal Field.

## Order—CHAMACEA.

### Family—TRIDACNIDÆ.

*Genus*—*EURYDESMA*, Morris and Sowerby, 1845.

(*Strzelecki's Phys. Descrip. N. S. Wales, &c.*, p. 275.)

*Obs.* Amongst the many interesting occurrences of New South Wales marine Permo-Carboniferous fossils in Queensland, not the least is that of a *Eurydesma*. The specimens, although calcified throughout, are much decorticated by weathering, but the outline of the two valves when united, the straight posterior hinge, and the deeply excavated lunular space, are all unmistakable evidences of the genus *Eurydesma*. In the umbonal region the shells are very thick, quite an inch, and the structure of the shell is very beautifully seen in some places, whilst the rugged cartilage furrows of the hinge are equally apparent.

\* Strzelecki's *Phys. Descrip. N. S. Wales, &c.*, 1845, t. 10, f. 3.

† *Ann. and Mag. Nat. Hist.*, 1847, xx., p. 302, t. 14, f. 4.

EURYDESMA CORDATA, *Morris*.

*Isocardia* ? sp., J. de C. Sby., Mitchell's Three Expeds. Int. E. Austr., 1838, i., p. 15, t. 2 [3], f. 1 and 2.

*Eurydesma cordata*, Morris, Strzalecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 276, t. 12.

" " Dana, Geology Wilkes' U. S. Explor. Exped., 1849, Vol. x., p. 700.

*Obs.* Several large and small shells from the Yatton Gold Field may be referred to this species, both from their massive shells and strong thick hinges, but they are too much weather-worn for general description. Dana mentions that in the half-broken-off beak of one valve "there is a tubular cavity, filled with rock, coming up obliquely from between the beaks, and passing out anteriorly, and this cavity is probably the byssiferous channel." A similar passage is visible in one of our specimens.

*Loc. and Horizon.* Yatton (*R. L. Jack* and *N. H. Burrowes*)—Mining and Geological Museum, Sydney)—Gympie Beds.

EURYDESMA SACCULUS, *McCoy*.

*Pachydomus sacculus*, McCoy, Ann. and Mag. Nat. Hist., 1847, xx., p. 301, t. 14, f. 5.

*Eurydesma sacculus*, Dana, Geology Wilkes' U. S. Explor. Exped., Vol. x., 1849, p. 700, Atlas, t. 7, f. 8a-c.

*Obs.* Several badly preserved examples are probably referable to this species. One in particular shows the characteristic satchel-shaped outline, and the short posterior compressed wing. The shell substance is very foliaceous, and it appears to have been a much less robust shell than *E. cordata*, Morris.

*Loc. and Horizon.* Yatton (*N. H. Burrowes*; Mining and Geological Museum, Sydney)—Gympie Beds.

## Order—VENERACEA.

## Family—CARDIIDÆ.

Genus—CONOCARDIUM, *Bronn*, 1835.

(*Lethæa Geognostica*, 1, p. 91).

CONOCARDIUM AUSTRALE, *McCoy*, Pl. 14, fig. 6.

*Pleuororhynchus australis*, McCoy, Ann. and Mag. Nat. Hist., 1847, xx., p. 30, t. 16, f. 4.

*Conocardium australe*, Etheridge fil., Cat. Australian Foss., 1878, p. 68 (for synonymy.)

*Obs.* The Gympie Beds have yielded a single example of a *Conocardium*, larger than Prof. McCoy's figure, but resembling his species in outline and appearance, except that the two diverging impressed lines on the shorter end of the shell are not visible. The difference in the strength of the striæ on the portions which would be bounded by these impressed lines is, however, quite apparent, and as described by McCoy. The carina of *C. australe* has a peculiar curve characteristic of the species.

*Loc. and Horizon.* Gympie (*R. L. Jack*)—Gympie Beds.

## Order—MYACEA.

## Family—ANATINIDÆ.

Genus—CHÆNOMYA, *F. B. Meek*, 1866.

(Pal. Up. Missouri, Pt. i., p. 42.)\*

*Obs.* The following species are provisionally referred to this genus, pending a detailed examination of allied forms from the Marine Series of the New South Wales Permo-Carboniferous rocks. It has been pointed out by Dr. Paul Fischer,† that the

\* Smithsonian Contributions to Knowledge, 1866, Vol. xiv., No. 172.

† Man. Conchyl. et de Pal. Conchyl., 1877, p. 1167.

European species referred by the late Prof. De Koninck to this genus do not wholly accord with those for which it was originally proposed by the late Dr. Meek. It is possible that the same objections can be raised against the Australian shells.\*

*CHÆNOMYA ? ETHERIDGEI, De Koninck, sp.*

*Sanguinolites Etheridgei*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 262, t. 17, f. 2 (non t. 16, f. 2).

*Sp. Char.* Shell of medium size, gibbous, curved, more or less oblique, and produced posteriorly; flanks very gibbous in the visceral region, rapidly decreasing to the ventral margin. Cardinal margin or hinge-line less than the length of the shell, to some extent curved upwards; ventral margin somewhat obliquely curved from before backwards. Anterior end subtruncate; posterior end obliquely and abruptly truncate, with a narrow gape. Umbones anterior and prominent; diagonal ridge rounded; posterior slope flattened. Lunule apparently elongated and narrow; escutcheon wide, and moderately long. Lines of growth rugged and coarse, with intermediate finer striæ.

*Obs.* The specimen from which the above characters are taken is rather crushed, and they are therefore open to modification. The diagonal groove represented in De Koninck's figure is not visible in the present example. It is a much longer species than *Chænomya ? acuta*, Etheridge, and the dorsal margin appears to rise rather more. In specimens of *C. Etheridgei* from the Maitland Coal Measures the diagonal ridge varies much in its development; in some it is very pronounced, in others but little apparent. How much of this is due to pressure and distortion it is difficult to say, but in some specimens it undoubtedly is the case, as it is accompanied by a greater or less degree of artificial inequivalvism; but in all such cases the width of the valves is much increased, as if by pressure from above.

*Loc. and Horizon.* Banana Creek, near Banana, Dawson River (*H. Mackay*; Colln. De Vis)—Middle or Marine Series, Bowen River Coal Field; ? Gympie (*W. H. Rands*)—Gympie Beds.

*CHÆNOMYA ? CARINATA, sp. nov.*, Pl. 43, figs. 5 and 6.

*Sp. Char.* Shell rhomboidal, short, oblique, gibbous, produced posteriorly, highly carinate. Cardinal margin short; lunule short and wide; escutcheon moderately wide and shallow, with sharp margins; ventral margin obliquely rounded. Anterior end small, very oblique; posterior end obliquely truncate, slightly gaping. Diagonal ridge very marked, prominent, and sharp; posterior slope concave, with a median groove or depression. Umbones prominent and terminal, incurved. Concentric ridges very coarse and widely separated, ending at the diagonal ridge, or but very little marked on the posterior slope.

*Obs.* These characters are taken from a decorticated specimen. This is a very marked shell when viewed in profile, from the great prominence of the diagonal ridge. When seen from above, across the valves, its great width at once attracts notice, being quite two-thirds the length of the shell. The short form, and the wide, highly carinate condition, without any sign of distortion, lead me to regard this as a distinct species.

*Loc. and Horizon.* Banana Creek, near Banana, Dawson River (*H. Mackay*; Colln. De Vis)—Middle or Marine Series, Bowen River Coal Field.

\* They certainly are not *Sanguinolites*, as that genus was restricted by De Koninck (see p. 281). I hope to work the groups out shortly. (*R.E. Junr.*)

## CHÆNOMYA? ACUTA, Etheridge, sp.

*Panopeaplicata*, var. *acuta*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., Pt. 3, p. 342, t. 21, f. 3 and 3a.

*Obs.* My Colleague states that the shell referred by Mr. Etheridge to the Cretaceous species *Panopea plicata*, Sby., under the varietal name *acuta* comes from the Permo-Carboniferous Series of the Bowen River Coal Field, and can therefore bear no relation to the form described by Sowerby.

Mr. Etheridge remarks that "our shell is more acute than Sowerby's typical form, the posterior or anal border or extremity in this variety being less truncated; it, however, gapes as much." It is not impossible that this fossil may be a species of *Chænomya*, although we at present know little of the external sculpture, whether granular or not. It is even possible, judging from the difference in outline of Mr. Etheridge's figures, that two species have been placed under the one name.

*Loc. and Horizon.* Pelican Creek, Bowen River (*The late R. Daintree*)—Middle or Marine Series, Bowen River Coal Field.

## CHÆNOMYA? BOWENENSIS, sp. nov.

*Sanguinolites* (comp. *S. clava*, McCoy), Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 302, t. 16, f. 54.

*Sp. Char.* Shell transversely elongate, produced, nasute, and sharp posteriorly, closed, very convex in the visceral region, rapidly decreasing towards the ventral margin. Cardinal margin or hinge-line straight; ventral margin convex; anterior end gibbous and inflated; posterior end much compressed or flattened, wedge-like, attenuating rapidly to a sharp, thin margin, which is narrowly rounded. Umbones quite anterior and terminal, inrolled, and depressed from above; no diagonal ridge, or defined posterior slope, but the flanks of the valves much inflated and gibbous. Lunule apparently somewhat cordate. Surface with rather broad, concentric lamellæ of growth, forming coarse rugæ on the flattened posterior end.

*Obs.* I formerly regarded this shell as a *Sanguinolites* and compared it to *S. clava*, McCoy, but it cannot be placed in that genus as now restricted. The following remarks were then made:—"With the exception of a somewhat shorter and more gibbous form, I am unable to distinguish this species from Prof. McCoy's *S. clava*. The specimen is a decorticated cast, there are no traces of muscular impressions left, and the valves have, by pressure, been slightly displaced. Notwithstanding this it is easily seen that the shell possessed a much more gibbous and rotund habit than *S. clava*, the relative convexity of the valves immediately below the beaks being greater. The rapid attenuation of the flanks towards the ventral margin, and the thinning-off of the posterior end, are as in *S. clava*, and there also existed a well-marked lunette and escutcheon, although the latter was much shorter than in McCoy's species. Lastly, the posterior slope is more defined in the Australian form, and the valves were closed posteriorly. Taking all these characters together, it must be conceded that, in all probability, the two species are distinct. A useful comparison might be made between Mr. Jack's shell and two Australian species described by Dana, did we only know more about them, viz.:—*Edmondia*? (*Pholadomya*) *glendonensis*,\* and *Sanguinolites* or *Edmondia*? (*Pholadomya*) *undata*.† The first, as figured by Dana, is a crushed-down shell, without form or character, and is simply unrecognizable; all one can say is, that it appears to be a shorter form than that now under discussion. The second is a very *Sanguinolites*-like shell, and is clearly separated from the latter by the position of the beaks, more than sub-central in position, and the consequently larger anterior end.

\* Geology Wilkes' U. S. Explor. Exped., 1849, Vol. x., Atlas, t. 2, f. 12.

† *Loc. cit.*, f. 11.

A glance at the so-called species of *Sanguinolites* described\* from the Carboniferous beds of New South Wales by Professor De Koninck (*S. Etheridgei*, *S. Mitchellii*, *S. McCoyi*, and *S. Tenisoni*), will show how little resemblance they bear to the Queensland fossil. Of them, *S. McCoyi* is certainly more nearly allied to the latter than any of the others. It has the outward appearances of the genus *Allorisma*, King,† but without a better knowledge of its internal characters it would not be wise to so refer it. It is certainly clear that, like the latter, it possessed an external ligament, but the impression of the pallial line is not retained. Again, the valves are more convex than is usually seen in *Allorisma*.

*Loc. and Horizon.* Coral Creek, Bowen River, below Sonoma Road-crossing (*R. L. Jack*)—Middle or Marine Series, Bowen River Coal Field.

Genus—*EDMONDIA*, De Koninck, 1842.

(Descrip. Anim. Foss. Terr. Carb. Belgique, p. 66.)

*EDMONDIA* ? *OBOVATA*, Etheridge.

*Edmondia obovata*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 328, t. 13, f. 3.

*Sp. Char.* "Shell ovate, anterior margin convex, or nearly circular; posterior margin slightly truncated; hinge-line nearly straight; umbones small, close to anterior side; ventral margin almost parallel with dorsal; outer shell wanting, but appears to have been concentrically banded." (*Etheridge*.)

*Obs.* This species was compared by Mr. Etheridge to *Pullastra ovalis*, McCoy, and *Edmondia* ? *compressa* of the Irish Carboniferous System.

It is an extremely difficult matter appropriating these indistinct casts to their proper genera. The present specimen is certainly not a *Myacites*, as alternatively suggested by its describer, nor does it agree well even with the characters of *Edmondia*. The figure seems to me to agree much more with the outline of the last genus, *Chænomya*?, than it does with either of the foregoing.

*Loc. and Horizon.* Beehive Reef, Gympie (*The late R. Daintree*)—Gympie Beds.

Genus—*SANGUINOLITES*, McCoy, 1844.‡

(Synop. Carb. Lime. Foss. Ireland, p. 47; Brit. Pal. Foss., 1852, Fasc. 2, p. 276.)

*SANGUINOLITES CONCENTRICUS*, Etheridge, sp., Pl. 43, fig. 7.

*Edmondia concentrica*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 328, t. 13, f. 2.

*Sp. Char.* Transversely elongated, oblong, valves rather compressed, hollowed on the flanks. Cardinal or dorsal margin straight posteriorly, inclined obliquely at the anterior end; ventral margin convex anteriorly and posteriorly, straight medially. Anterior end long, narrowed, and flattened; posterior end longer than the anterior, with a semi-truncate margin; posterior slope very much flattened, hardly defined by any diagonal ridge, and entire. Umbones inconspicuous, depressed, sub-median in position. Surface with numerous concentric lines of growth, arranged in band-like zones, distant from one another.

\* Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, pp. 261-265, t. 16 and 17. These are not *Sanguinolites*, as the genus is now restricted.

† Mon. Perm. Foss. England, 1850, p. 196.

‡ Restricted, De Koninck, Faune Calc. Carb. Belgique.

*Obs.* A very poor example was figured by Mr. Etheridge to "draw the attention of Australian geologists to the Lamellibranchiata of the Palæozoic rocks of Queensland, and elsewhere through the colony, in the hope that search may be made for more perfect specimens."

As the anterior of the shell is unknown its generic affinity must remain doubtful, but it seems to accord better with the late Prof. De Koninck's restriction of *Sanguinolites* than with *Edmondia*, to the type species of which it bears resemblance. There is a decided posterior slope present, but only the faintest trace of a diagonal ridge.

*Loc. and Horizon.* Gympie (*The late R. Daintree—G. Sweet*); the Gas Works, Gympie (*W. H. Rands*)—Gympie Beds.

### Family—SAXICAVIDÆ. ?

*Genus—PACHYDOMUS, Morris, 1845.*

(Strzelecki's Phys. Descrip. N. S. Wales, &c., p. 271.)

*Obs.* In the "Catalogue of Australian Fossils," and in the description of the "Fossils of the Bowen River Coal Field," attention was called by the Writer to the difficulties attending a proper distribution of the species of Dana's genera, *Mæonia* (vel. *Myonia*), *Pyramia* (vel. *Pyramus*), and *Cleobis* as pointed out by the late Dr. Stolitzka. In Professor Dana's first Paper on Australian Palæontology, contributed to the pages of the *American Journal of Science*, the three were described as separate and distinct genera, but in the more extended account of the Geology of the "Wilkes Exploring Expedition" they were united under the one name *Mæonia*. Dana at the same time stated that his *Pyramia* was identical with *Notomya*, McCoy. The arrangement adopted in the Catalogue was a purely provisional one, proposed more as a temporary suggestion than as an accurate solution of a difficult and obscure subject. Reasons were also given for adopting the name *Notomya*, McCoy, in preference to any of the others.

Further study of this subject has not ended in any very satisfactory result, as the material in the National Collection, London,\* although large, is not sufficient for the purpose in view. Added to this, the discrepancies between the various descriptions are so marked that it becomes quite impossible to adjudicate on the relations of the species referred to the genera in question. *Pachydomus* and *Notomya* will probably stand as good genera, certainly the former, and it is quite possible that it will be necessary to some extent to rehabilitate *Mæonia*, Dana.

I hope, before any lengthened period has passed away, to make a complete study of this group of shells, but from the paucity of material it will be no easy task.

### PACHYDOMUS GLOBOSUS, *J. de C. Sowerby*, sp.

*Megademus globosus*, J. de C. Sowerby, Mitchell's Three Exped. Int. E. Australia, 1838, i., p. 15, t. 3, ff. 1 and 2.

*Pachydomus globosus*, Morris, Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 272, t. 10, f. 2 and 3.

*Cleobis grandis*, Dana, American Journ. Sci., 1847, iv., p. 154.

*Mæonia grandis*, Dana, Geology Wilkes' U. S. Explor. Exped., Vol. x., 1849, p. 697, t. 6, f. 8.

*Pachydomus globosus* (pars.), Etheridge fil., Cat. Australian Foss., 1878, p. 75.

„ „ Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 301.

*Obs.* The fossiliferous rock of Pelican Creek has furnished a ponderous example of this species, but in a wretched state of preservation, without any trace of shelly matter remaining, and the whole substance of the cast having assumed the form of a

\* This was written before I had left London. I am sorry to say that I do not find that the material in Sydney will advance the subject much. (*R. E. Junr.*)



decomposed ferruginous ironstone nodule. The specimen measures roughly about eight inches by five and a half, without the shelly matter. Across the dorsal region, from the one rounded diagonal ridge to the other, the shell measures at least five inches. This will give some idea of the great breadth attained by this species, and its general globose or gibbous outline. The umbones are very large, incurved, and quite anterior. Judging by the space occupied by matrix between the cardinal edges of the two valves, the ligament must have been of great dimensions and strength. The collection contains two examples of this species, that from which the foregoing notes are taken, and a smaller one, which is believed to represent the young condition of the species. The latter, when held in certain lights, shows indistinct traces of radiating striæ in the cast. Upon examining a remarkably fine specimen in the late Count Strzelecki's Collection, I find that it also, where the shelly matter is worn off, exhibits similar radiating ridges. In the paper on the Bowen River Coal Field Fossils I overlooked the fact that Prof. J. D. Dana had already called attention\* to the identity of his *Cleobis grandis* and *Pachydomus globosus*, Morris.

My Colleague has obtained a specimen, denuded of all external shelly matter, from the Gympie Gold Field, which, although small, may be an individual of the present species; it is, however, too imperfect to name definitely.

*Loc. and Horizon.* Pelican Creek, Bowen River, half-a-mile above Sonoma Road-crossing, in a highly fossiliferous concretionary and ferruginous mudstone; Pelican Creek, in a sandstone above the Garrick Coal-seam—both horizons in the Middle or Marine Series, Bowen River Coal Field (*R. L. Jack*).

#### Genus—*MÆONIA*, Dana, 1847.

*Myonia*, Dana, American Journ. Sci., 1847, iv., p. 158.

*Mæonia*, Dana, Geology Wilkes' U. S. Explor. Exped., Vol. x., 1849, p. 694.

*Obs.* This genus is provisionally used, pending a detailed examination of all these dubious Permo-Carboniferous Bivalves, for shells after the type of *M. elongata*, Dana, and *M. carinata*, Morris, sp. The muscular system of the latter is quite different to that of various genera in which it has been placed, and accords better, although not exactly, with the characters of *Mæonia* as laid down by Dana in his latter description.

#### *MÆONIA CARINATA*, Morris, sp.

*Pachydomus carinatus*, Morris, Strzelecki's Phys. Descrip. N. S. Wales, 1845, p. 273, t. 11, f. 3 and 4.

*Cypricardia rugulosa*, Dana, American Journ. Sci., 1847, iv., p. 157.

*Pachydomus carinatus*, McCoy, Ann. and Mag. Nat. Hist., 1847, xx., p. 301.

*Mæonia* ? *carinata*, Dana, Geology Wilkes' U. S. Explor. Exped., p. 696, Atlas, t. 6, f. 1a and b.

*Pleurophorus* ? *carinatus*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 283, t. 19, f. 8.

*Pachydomus* ? *carinatus*, Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 300, t. 16, f. 53.

*Notomya* (*Mæonia*) *elongata*, Ratte (non Dana), Proc. Linn. Soc. N. S. Wales, 1887, ii., Pt. 1, p. 139, t. 3.

*Obs.* The strongly marked umbonal ridge, and the slightly concave posterior slope, at once mark this species as peculiar. Two specimens in a moderately good state of preservation were obtained in the Bowen River Coal Field; both have the entire shell removed, and are therefore in the form of casts, but with the exception of some slight displacement of the valves, the general outline is retained. I formerly placed this species in *Pachydomus*, but both this reference and Prof. De Koninck's to the genus *Pleurophorus* I now believe to be erroneous. The shell does not coincide with the original types of *Pachydomus*, such as *P. antiquatus* and *P. cuneatus*.† With regard to

\* American Journ. Sci., 1848, v., p. 435.

† *Megadesmus*, J. de C. Sowerby, in Mitchell's Three Expeds. Int. E. Australia, 1838, i., p. 15, t. 1, f. 2 and 3.

*Pleurophorus*, I have quite failed to trace a dental structure in any of the casts of *M. carinata* examined, and of which there are several good examples in the Australian Museum. *M. carinata* seems to be wholly devoid of hinge teeth, but possesses a very peculiar system of muscular scars. These have been well figured by the late Mr. Felix Ratte,\* and still further show its dissimilarity to *Pleurophorus*.

The double anterior and fringed muscular scars, and the accessory scars at the apex of the beaks, accord with the characters originally laid down by Dana for his genus *Mæonia*, and I think it not improbable that this name will have to be retained for transversely elongate shells with the above characters, typified by *M. elongata*, Dana, and *Pachydomus carinatus*, Morris.

*Loc. and Horizon.* Coral Creek, Bowen River, below Sonoma Road-crossing; Bowen River, at No. 25 Traverse Station (*R. L. Jack*)—Middle or Marine Series, Bowen River Coal Field.

#### MEONIA RECTA, Dana.

*Cleobis recta*, Dana, American Journ. Sci., 1847, iv., p. 154.

*Mæonia recta*, Dana, Geology Wilkes' U. S. Explor. Exped., 1849, Vol. x., p. 698, Atlas t. 7, f. 2.

*Notomya (Mæonia) recta*, Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 299.

*Obs.* The chief characters of this species are its very inequilateral and oblong form with the parallel dorsal and ventral margins. Professor Dana's specimen measured three and a-half inches in length, but the shell here referred to *C. recta* measures seven and a-quarter inches in the same direction. Like all the Bivalves in my Colleague's Bowen River Collection, the state of preservation is very bad, but there appears to be the remains of an obscure posterior slope, a character which is not mentioned in Dana's description.

The generic affinities are by no means clear, a state of matters common to a number of these Bivalves, and even Dana appears to have figured an imperfect example.

*Loc. and Horizon.* Coral Creek, Bowen River, below Sonoma Road-crossing, in a yellow micaceous decomposed ironstone, of the Middle or Marine Series, Bowen River Coal Field (*R. L. Jack*).

### Class—GASTEROPODA.

### Order—PROSOBRANCHIATA.

#### Family—NATICIDÆ.

#### Genus—NATICOPSIS, McCoy, 1844.

(Synop. Carb. Lima. Foss. Ireland, p. 33.)

#### NATICOPSIS ? HARPEFORMIS, Etheridge, Pl. 15, fig. 10.

*Naticopsis harpeformis*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., Pt. 3, p. 337, t. 18, f. 6.

*Obs.* Under the above name Mr. Etheridge figured a fragment of a very problematical fossil. He considered it to be a portion of the body-whorl of a naticiform shell, the suture being ornamented with "thirty or thirty-five nodes or tubercles, each of which occupies the summit of a rib or varice." He further pointed out that the whorls of some species of *Loxonema* are similarly ornamented. On the other hand, Prof. John Morris suggested that the fossil might be a portion of a small *Goniaticites*, with a wide umbilical cavity.

Either of these views may be the correct one, so very doubtful are its affinities.

*Loc. and Horizon.* Don River (*The late R. Daintree*)—Gympie Beds.

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\* Proc. Linn. Soc. N. S. Wales, 1887, ii., Pt. 1, p. 139, t. 3.

NATICOPSIS VARIATA, *Phillips*, sp. ?

*Natica variata*, Phillips, Ill. Geol. Yorksh., 1836, Pt. 2, p. 224, t. 14, f. 26 and 27.

*Naticopsis variata*, McCoy, Brit. Pal. Foss., 1852, fas. 2, p. 544.

*Obs.* We are acquainted with a shell possessing the general outline of this species, but only in the form of casts, from the Corner Creek Beds. The spire was small, the body-whorl large and ample, and the ornament consisted of strong striæ in and emerging from the suture, as in the above species. On the other hand, the spire, although small, was, perhaps, rather too large for *N. variata*, and it has therefore been thought advisable to give this determination with a note of interrogation.

*Loc. and Horizon.* Corner Creek, Great Star River (*R. L. Jack*)—Star Beds.

NATICOPSIS, *sp. ind.*

[Compare *N. elongata*, Phill., *loc. cit.*, t. 14, f. 28.]

*Obs.* A single cast obtained from the same beds by Mr. P. W. Pears resembles *Naticopsis elongata*, Phill., in obliquity and general appearance, although a subangulation of the body-whorl will probably separate the two forms. It likewise has rather the appearance of some *Platystomæ*, but is devoid of the reflected and sinuous lips of those shells. It is difficult to say how far distortion might alter the outline of the shells previously compared to *Naticopsis variata*, but hardly to such an extent as to merge the two forms under consideration into one.

*Loc. and Horizon.* Corner Creek, Great Star River (*P. W. Pears*)—Star Beds.

## Family—PYRAMIDELLIDÆ.

Genus—LOXONEMA, *Phillips*, 1841.

(Pal. Foss. Devon., p. 98.)

*Obs.* A crushed example of a *Loxonema* (Pl. 15, fig. 17), of a type common in Carboniferous rocks was communicated by the late Mr. James Smith. The whorls are ribbed with many longitudinal, slightly bent ridges or costæ. There are traces of ten faintly convex whorls. The shell is of the type of *Loxonema rugifera*, Phill.

*Loc. and Horizon.* Stony Creek, Stanwell, near Rockhampton (*The late J. Smith*)—Gympie Beds.

## Family—EUOMPHALIDÆ.

Genus—EUOMPHALUS, *J. Sowerby*, 1814.\*

(Min. Con., p. 97.)

*Obs.* The presence of this genus in the Permo-Carboniferous of Queensland is placed beyond doubt by the occurrence of a few indifferently preserved casts in the Stanwell Beds. None are sufficiently well preserved for specific description, but two undoubtedly indicate the genus as now restricted and typified by *Euomphalus pentangulatus*. The best of these has a diameter of one inch, the under surface round, and the upper supporting a sharp prominent keel; in fact the whole appearance of the shell is very much that of the species named.

In the Star River Beds a number of small Euomphaloid shells (Pl. 14, fig. 21) are met with. The test has entirely disappeared, and the specimens have undergone so much decay that it is with difficulty they can be assigned to any particular genus. Their place will probably be found with the present one.

*Loc. and Horizon.* Stony Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

\* Emended, De Koninck, Faune Calc. Carb. Belgique, Pt. 3 (*Ann. Mus. R. Hist. Nat. Belgique*, 1881, vi.), p. 156.

Genus—*PLATYSCHISMA*, McCoy, 1844.

(Synop. Carb. Lime. Foss. Ireland, p. 38.)

*PLATYSCHISMA OCULUS*, J. de C. Sowerby, Pl. 15, figs. 3 and 4.*Trochus oculus*, J. de C. Sowerby, Mitchell's Three Exped. Int. E. Australia, 1838, i., p. 15, t. 2, f. 3 and 4.*Platyschisma oculus*, Morris, Strzelecki's Phys. Descrip. N. S. Wales, 1845, p. 286, t. 18, f. 1.*Euomphalus oculus*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 330, t. 23, f. 18.

*Obs.* Two specimens, which I am quite unable to refer to any other than this species, have been obtained through the painstaking efforts of the late Mr. James Smith. Neither is in a good state of preservation, one being only a portion of a specimen, whilst the other was evidently much crushed during the life of the shell, and naturally repaired, whereby the base has been obliquely pressed inwards, and the umbilicus thrown out of place. The body-whorl is, to some extent, channelled or flattened along the suture, a feature also visible in some varieties of *P. oculus*.

*Loc. and Horizon.* Stony Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds.

*PLATYSCHISMA ROTUNDA*, Etheridge, Pl. 15, fig. 6.*Pleurotomaria rotunda*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 336, t. 18, f. 3.

*Sp. Char.* Shell turbate or trochiform, with four whorls; apex slightly depressed; aperture suboval or subangular. Whorls completely rounded and concentrically striated, with numerous close-set costæ, which are crossed diagonally from the mouth backwards by very fine lines, giving the shell a reticulate appearance. Base slightly convex. Umbilicus very small or obsolete. Sinus scarcely distinguishable. (*Etheridge.*)

*Obs.* This shell appears at first sight to be smooth, the ornamentation being microscopic, yet definite; on a portion only of the shell is there structure remaining. In form, size, and general aspect, *P. rotunda* resembles *P. granulata*, De Kon., but the sculpturing of the shell, and the band-like sinus, remove it from that species. *P. rotundata*, Phill., in the rotundity of the whorls and other minor points, somewhat resembles it, but our species is much less acute in the spire. (*Etheridge.*)

*Platyschisma rotunda* possesses a most suspicious resemblance to *P. oculus*, but the figure of the former affords no evidence of an umbilicus, and its umbilicus is even described as very "small or obsolete." If there is no umbilicus, or, on the other hand, if the shell really has a band and sinus, it cannot be a *Platyschisma*, but generally it very closely resembles this genus.

An impression of a much smaller shell, but one otherwise resembling *P. rotunda*, has been collected by Mr. C. W. De Vis in the Rockhampton Beds. The spiral striæ mentioned in the above description are not visible, but the diagonal lines are very apparent, and are more or less sigmoidal. On the whole it very much resembles a young condition of *Platyschisma rotunda*.

*Loc. and Horizon.* Cracow Creek, Dawson River, Lat. 25° 20' S., Long. 150° 15' E., approximately (*The late R. Daintree*)—Middle or Marine Series, Bowen River Coal Field; Rockhampton District\* (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

\* See note, p. 199.

## Family—PLEUROTOMARIIDÆ.

## Genus—PLEUROTOMARIA, DeFrance, 1824.

(Tableau, p. 114.)

## PLEUROTOMARIA CARINATA, J. de C. Sby. ? Pl. 15, fig. 16.

*Pleurotomaria carinata*, J. de C. Sowerby, Min. Con., vii., p. 70, t. 640, f. 3.*Pleurotomaria carinata*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., Pt. 3, p. 331, t. 15, f. 6.

*Sp. Char.* Shell depressed, composed of three or four whorls; base flat; body-whorl large, expanded, the two upper whorls (in our specimen) distorted; umbilicus not seen; shape of aperture doubtful; no shell structure left. (*Etheridge*.)

*Obs.* I can scarcely detect any difference between the form and habit of this shell and those of *Pleurotomaria carinata*, Sby. Its size is greater; but unfortunately the loss of the outer shell prevents our seeing the band or slit at the edge of the whorl, in the absence of which it might be referred to *Raphistoma* or *Platyschisma*; it is not, however, sufficiently depressed to be referred to the former genus. (*Etheridge*.)

If this shell is correctly referred to J. de C. Sowerby's *Pleurotomaria*, it must be very much distorted, for the species in question does not possess the obliquity of the Queensland shell, nor is the band on the body-whorl so sharp and prominent. From the condition of the specimen, as represented by the figure, it is impossible to say to which section of the large genus *Pleurotomaria*—whether *Ptychomphalus*, Agassiz, or *Mourlonia*, De Koninck—it should be referred.

*Loc. and Horizon.* Gympie (*The late R. Daintree*)—Gympie Beds.

## Genus—MOURLONIA, De Koninck, 1883.

(Ann. Mus. R. Hist. Nat. Belgique, viii., p. 75.)

## MOURLONIA STRZELECKIANA, Morris, sp., Pl. 15, fig. 2.

*Pleurotomaria Strzeleckiana*, Morris, Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 287, t. 18, f. 5.

" " Plews, Min. Inst. Journ., 1858, vi., Pt. 3, t. 4, fig.

*Obs.* To this species is referred an internal cast, with the whole of the test removed. It is about two inches in height, with four whorls remaining, but on the whole it appears to be a rather more inflated form than the type figured by the late Professor Morris. The band is but very faintly preserved on the fore part of the body-whorl.

The specimen is much too high a shell for *Platyschisma rotunda*, Etheridge, although generally like it. The whorls are rounder, and there is an entire absence of angulation.

An internal cast of four or more whorls of a roundly whorled shell, without any distinctive character, or angulation of the spiral, but possessing a distinct and well-marked band, has been collected in the Burnett District, and may be the present species. There is a moderately large umbilicus.

*Loc. and Horizon.* Blenavon, near Rockhampton (*The late James Smith*); Sandstone, near Yarrol Station, Burnett (*W. H. Rands*)—Gympie Beds.

## MOURLONIA ? CONIFORMIS, sp. nov., Pl. 41, fig. 5.

*Sp. Char.* Shell elongately conical, six to seven whorls, each somewhat convex above the band, which is sutural and straight-sided; body-whorl, mouth, &c., not preserved. Ornament consists of strong spiral costæ, distinct from one another, crossed by oblique and finer lines, giving rise to a coarse reticulation.

*Obs.* This unsatisfactory specimen is figured more as a record of a species than as affording detailed characters of the same. The specimens are impressions of the apical portions from which casts have been taken. The reference to *Mourlonia* is even provisional, and has been made from the outward resemblance of the fossils to species of that genus.

*Loc. and Horizon.* Banana Creek, near Banana, Dawson River (*H. Mackay*; Colln. De Vis)—Middle or Marine Series, Bowen River Coal Field.

*Genus*—*YVANIA*, *Bayle*, 1885.\*

*Obs.* *Yvania* is another offshoot from the old genus *Pleurotomaria*, in its Carboniferous sense. It is, in fact, a turriculated *Pleurotomaria*, in which the horizontal and vertical portions of each whorl unite in a right angle. The band and its sinus are on the flat or horizontal portions, and it is impossible to see them in a side or profile view. The shells are ornamented by spiral grooves and ridges, and there is a small umbilical fossette.

*Yvania* is typified by the Belgian *Trochus Yvanii*, Leveillé.

*YVANIA KONINCKI*, *Eth. fil.*, Pl. 41, fig. 7.

*Baylea Koninckii*, *Eth. fil.*, Records Geol. Survey N. S. Wales, 1890, ii., Pt. 2, p. 82.

*Sp. Char.* Shell small, conical, of about six angular and deeply carinated whorls. Aperture unknown. Upper portion of the whorls not absolutely flat, but a little sloping, at the edge of which, and the vertical part of the whorl, is situated the band. On the former are placed eight sharp, spiral ridges, with wide semi-concave interspaces, but no evidence of any cross striation. Umbilicus small and inconspicuous. Height, eight millimetres (in a broken state).

*Obs.* This is a very pretty shell, coming nearest to the European *Yvania spirata*, De Koninck; it is, however, much less in size and has a more prominent band.

*Loc. and Horizon.* Rockhampton District † (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

*Genus*—*LUCIELLA*, *De Koninck*, 1883.

(*Ann. Mus. R. Hist. Nat. Belgique*, viii., p. 107.) ‡

*Obs.* A depressed, conical, and trochiform *Pleurotomaria*-like shell, usually rough and lamellar, and variously ornamented. The body-whorl frequently becomes flattened and partially horizontal, with a sharp periphery, below which, on the lower side, the band is situated.

Casts of a small shell have been found in the Rockhampton Beds, probably referable to this genus.

*LUCIELLA*? *GRAYE*, *sp. nov.*, Pl. 41, fig. 6.

*Sp. Char.* Depressed trochiform, of four or five whorls, the upper ones conical, but the body-whorl more or less concave, turning upwards towards the periphery, which is sharp. Surface of each whorl crossed by transverse oblique and curved striae, and with equally fine spiral striae, the points of intersection becoming minutely nodular, producing a most delicate reticulation.

\* *Teste Fischer* (*Man. Conchyl. et de Pal. Conchyl.*, 1887, p. 857) = *Baylea*, De Koninck (*Ann. Mus. R. Hist. Nat. Belgique*, 1883, viii., p. 68), non *Bayleia*, M. Chalmas, 1873.

† See note, p. 199.

‡ *Faune du Calcaire Carbonifère de la Belgique*, Pt. 4.

*Obs.* The under surface of this interesting shell is unknown, and it is with some doubt that the reference to *Luciella* is made; on the other hand, I do not know in what other genus to place it. Unfortunately, like so many of the Queensland fossils, the specimens are but impressions, and indifferent ones.

I have much pleasure in naming the species after Mrs. Robert Gray, of Edinburgh, an ardent Collector, and to whom Prof. Alleyne Nicholson and the Writer were indebted, in years gone by, for an opportunity of describing many interesting fossils.

*Loc. and Horizon.* Rockhampton District \* (*C. W. De Vis*; Colln. *De Vis*)—Gympie Beds.

*Genus*—*MURCHISONIA*, *D'Archiac* and *De Verneuil*, 1841.

(Bull. Soc. Géol. France, xii., p. 154.)

*MURCHISONIA CABINATA*, *Etheridge*, Pl. 15, fig. 9.

*Murchisonia carinata*, *Etheridge*, Quart. Journ. Geol. Soc., 1872, xxviii., p. 337, t. 18, f. 5.

*Sp. Char.* Shell elongated, of many whorls (four exposed), strongly keeled or carinated along the middle of each whorl; no ornamentation seen, being a cast only. (*Etheridge*.)

*Obs.* Although but a very simple form of *Murchisonia*, Mr. *Etheridge* was unable to name any species with which it corresponded. The position of the angulation of the whorl, low down, and presumed also that of the band, with the proportions of the whorls, should serve to distinguish the species.

*Loc. and Horizon.* Don River (*The late R. Daintree*)—Gympie Beds.

Other fragmentary remains of this genus have been obtained by Mr. *C. W. De Vis* in the Rockhampton Beds, but they are quite beyond naming, although clearly distinct species from the above. They are:—

- (a.) A small species of nine or ten broad, but not high, simple, carinate whorls—no evidence of the aperture or ornament. It resembles *M. carinata* in appearance, but possesses at least nine whorls in a length of nine-sixteenths of an inch, whereas in the former there are four in thirteen-sixteenths.
- (b.) A second species of the same general character, but with four or five whorls in the same space—viz., nine-sixteenths of an inch.
- (c.) A still larger species, two and two and a-half inches in length, with a well-marked band, situated immediately above the suture on all the whorls, but the last one is not preserved, all crossed by oblique striæ.

Family—*BELLEROPHONTIDÆ*.

*Genus*—*BELLEROPHON*, *De Montfort*, 1808.

(Conch. Systématique, i., p. 51.)

*BELLEROPHON STANVELLENSIS*, *sp. nov.*, Pl. 15, figs. 11-13.

*Sp. Char.* Shell broad-oval, thick, higher than wide, whorls broad and somewhat depressed, back generally rounded, and but little excavated on each side of the keel; flanks very obtusely rounded, or even slightly flattened, but in no case angular. Mouth almost semi-circular and much expanded, inner lip spreading over last whorl as a thick wide callosity, and horizontally to join the margins of the outer lip as a lateral

\* See note, p. 199.

expansion. . Umbilicus open and deep, visible in a side view, but quite hidden from the front by the alate expansions of the inner lip. Keel narrow and sharp, and but little elevated. On the surface, striæ pass directly across the back from the keel to the peripheries above the umbilicus, but do not appear to cross the keel.

*Obs.* I, at first, took this to be one or other of the Salt Range (India) species, such as *B. Blanfordi*, *B. affinis*, or *B. Jonesianus*. From the first two, our species differs in the shape of the whorls, from the third by being less globose, and from all three in the nature of the surface ornament, and the exposure of the umbilicus. It appears to belong to the group of *Bellerophon hiulcus*, Sby., to which it is probably most nearly allied, but the mouth is more depressed and lunate, and the callosity deeper and more pronounced. It is the largest *Bellerophon* I have yet seen from Australian rocks, and is a peculiar form in so far that it unites the characters of more than one group.

*Loc. and Horizon.* Stony Creek, Stanwell, near Rockhampton (*The late James Smith*)—Gympie Beds; Banana Creek, near Banana, Dawson River (*H. Mackay*; Colln. De Vis)—Middle or Marine Series, Bowen River Coal Field.

*Genus—BUCANIA, Hall, 1847.*

(Pal. New York, i., p. 32.)

*BUCANIA TEXTILIS, De Koninck, Pl. 41, fig. 8.*

*Bellerophon decussatus*, De Koninck (*non Fleming*), *Descrip. Anim. Foss. Terr. Carb. Belgique*, 1843, t. 29, f. 2a-d (*excl. f. 3a and b*).

*Bucania textilis*, De Koninck, *Ann. Mus. R. Hist. Nat. Belgique*,\* 1883, viii., p. 150, t. 41, f. 22-25.

*Obs.* There is a very close resemblance between the shell originally called *Bellerophon decussatus* by De Koninck—but which is not the species of that name of Fleming—and the subject of our figure (Pl. 41, fig. 8). It has been subsequently named *Bucania textilis*, and is a globular, high shell, with a deep umbilicus. The aperture is large and rather trumpet-shaped, with a thin expanded callosity and a rather shallow sinus. The band is large, projects but little, and is covered with small scales. The entire shell is ornamented with spiral ridges well separated from one another, with finer interpolated ribs, and crossed by striæ of growth, which give to it a roughly and irregularly decussated appearance.

In the Australian shell the umbilicus seems to be rather larger than in the European.

*Loc. and Horizon.* Rockhampton District † (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

*Genus—PORCELLIA, Leveillé, 1835.*

(Mém. Soc. Géol. France, ii., p. 39.)

*PORCELLIA PEARSI, sp. nov., Pl. 15, figs. 7 and 8.*

*Sp. Char.* Shell small, of five or six whorls; section apparently quadrangular, back slightly convex or almost flat; sides of each whorl bearing prominent, elongated, obtuse tubercles, which gradually, and on the body-whorl insensibly, diffuse themselves on to the sides and back. Surface of the whole shell ornamented with spiral and transverse raised striæ, giving rise to a fine regular reticulation, the points of intersection becoming minutely nodular.

\* Faune du Calcaire Carbonifère de la Belgique, Pt. 4.

† See note, p. 199.



*Obs.* Although this species has only been met with in fragments, its characters are seen to be at once clear and distinct, the large elongated tubercles and fine reticular ornament rendering it a conspicuous fossil. The tubercles are transversely elongated, and gradually rise from the sides and back of the shell.

*Porcellia Pearsi* agrees with *P. puzio*, Leveillé,\* and *P. armata*, De Verneuil,† in the form and position of the tubercles, and with the former in the reticulation of the surface, but it differs from this particular species in the back of the body-whorl being flat, or practically so. From *P. armata* the present species may be distinguished by the nature of the ornamenting striæ, and the number of tubercles to the whorl. The nearest ally of *P. Pearsi* appears to be *P. Edouardi*, D'Orb.,‡ from the Middle Devonian of the Eifel, both as to general form and surface ornament, but here again the back is highly convex and the decussating striæ much stronger, whilst the tubercles are less marked and do not project to the extent they do in *P. Pearsi*.

*Loc. and Horizon.* Corner Creek, Great Star River (*P. W. Pears*)—Star Beds; Rockhampton District (*C. W. De Vis*; Colln. De Vis)—Gympie Beds; Banana Creek, near Banana, Dawson River (*H. Mackay*; Colln. De Vis)—Middle or Marine Series of the Bowen River Coal Field.

## Class—PTEROPODA.

### Order—THECOSOMATA.

#### Family—CONULARIIDÆ.§

*Genus*—*CONULARIA*, Miller (*J. Sowerby*), 1820.

(Min. Con., iii., p. 107.)

#### *CONULARIA TENUISTRIATA*, McCoy.

*Conularia tenuistriata*, McCoy, Ann. and Mag. Nat. Hist., 1847, xx., p. 307, t. 17, f. 7 and .

„ „ De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 310, t. 23, f. 2.

*Obs.* A small portion of an individual, exhibiting the number of fine transverse striæ mentioned by Prof. McCoy as twenty-seven to twenty-nine in the space of half-an-inch, and the upward curve across the broad face, which carries a mesial line, would appear to indicate this species as a Queensland fossil.

*Loc. and Horizon.* Gympie (*W. H. Rands*)—Gympie Beds.

#### *CONULARIA, sp. ind.*, Pl. 41, fig 10.

*Obs.* Another fragment, one and a-quarter inches long, with portions of thirteen wide and flat ridges, divided by similar interspaces. A mesial line traverses the centre longitudinally, representing one of the angles of the shell. Some of the cross ridges are subalternate, and where they abut against the mesial line are slightly grooved. The interspaces are cross-wrinkled, a similar form of ornament being visible in De Koninck's figure of *Conularia lævigata*, Morris,|| but no mention is made of it in the description. This is altogether a remarkable fragment, but is far too large for the above species.

*Loc. and Horizon.* Gympie (*W. H. Rands*)—Gympie Beds.

\* Mém. Soc. Géol. France, 1835, ii., p. 39, t. 2, f. 10 and 11.

† Geol. Russia d'Europe, 1845, ii., p. 346, t. 24, f. 3.

‡ Hist. Nat. Cephalopoda Acétab. 2me pte., p. 215, Atlas (Cryptodibranches), t. 7, f. 6 and 7.

§ S. A. Miller, American Pal. Foss., 1877, p. 141.

|| Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, t. 18, f. 9a.

## Class—CEPHALOPODA.

## Order—TETRABRANCHIATA.

## Family—NAUTILIDÆ.

Genus—*NAUTILUS*, *Breynius*, 1732.

(Dissert. Phys. Polythalamia.)

*Obs.* *Nautilus*, or one of its sections, is represented by a decorticated fragment, too imperfect to figure, of a small shell nearly an inch in diameter. There are eight septa visible, and, for the size of the specimen, a large umbilicus. This is the only indication of this genus I have met with in the Queensland Permo-Carboniferous rocks, with the exception of the following peculiar species.

*Loc. and Horizon.* Rockhampton District \* (*C. W. De Vis*; Colln. *De Vis*)—Gympie Beds.

*NAUTILUS ? AMMONITIFORMIS*, *sp. nov.*, Pl. 39, fig. 9; Pl. 41, fig. 9.

*Sp. Char.* Shell planorbiform, apparently much depressed, of many closely coiled, convex, uniform, narrow, tube-like whorls in one plane, and, with the exception of the body-whorl, expanding but very slowly. The latter is much flatter and broader than the others, and has lost the tube-like appearance of the inner and older whorls; aperture unknown. Surface of all but the body-whorl with angular, direct, transverse ridges, or costæ, separated by interspaces of more than their own width, but on the latter they become flattened, depressed ribs, somewhat sigmoidal, presenting a very different appearance.

*Obs.* A very peculiar shell, which from its general appearance would seem to be more nearly allied to the Cephalopoda than the Gasteropoda. Not the least peculiar feature is the remarkable regularity of the coil in one plane, whereby the enlargement of the whorls is hardly perceptible until the body-whorl opens out. There are no septa visible, but, on the other hand, the appearance of this shell is quite different to that of any of the Euomphalidæ, and the sudden expansion of, and change of ornament on the body chamber, cause me to regard it as a Cephalopod. There are traces of a ventral keel, but no spiral striæ. The costæ on the older chambers are at right angles to the coil, but the ribs on the last chamber assume an oblique direction. The last whorl, and the inner whorls (Pl. 39, fig. 9), are frequently found disconnected, when they might be readily mistaken for two distinct species.

I have been much perplexed with regard to a genus for this fossil, and it is only placed in *Nautilus* as a matter of convenience, as it is obvious that no real relation exists between the two. As a matter of fact, in outward appearance, these fossils present an exact resemblance to *Lituites*, especially that section named by Barrande *Ophidioceras*.† There is the same coil-like form in one plane, tube-like whorls, and separate transverse costæ. But *Lituites* is a Silurian genus and confined to rocks of that age throughout the world. Otherwise, had intermediate Devonian species existed, I should have been tempted to refer the present species to it. On the other hand, this may be one of those extraordinary survivals of an old genus for which the Australian Palæontological record is becoming noted.

\* See note, p. 199.

† *Syst. Sil. Centre Bohême*, 1865, ii., Céph. 1s. Ser., Pls. 1 107, t. 45, f. 13, 17, 22, 23, 24, &c

It also resembles some species of *Trochoceras*. The older and inner whorls of this shell are very like a Cephalopod called *Nomismoceras spiratissimum*, Holzapfel,\* from the Carboniferous Limestone of Erdbach near Herborn, Germany, but the latter species appears to be smooth, and the whorls do not appear to enlarge and expand in the manner shown.

*Loc. and Horizon.* Rockhampton District † (*C. W. De Vis* and *Rev. J. E. Tenison Woods*; Colln. De Vis)—Gympie Beds.

### Family—ORTHO CERATIDÆ.

#### *Genus—ORTHOCERAS, Breynius, 1732.*

(Dissert. Phys. Polythalamis, pp. 12 and 23.)

*Obs.* The remains of this genus appear to be very uncommon in the Queensland Permo-Carboniferous Series, and when met with exceedingly fragmentary.

A terminal portion of an *Orthoceras* (Pl. 15, fig. 1), three inches long and rather crushed, was obtained from the Gympie Beds. Its present diameter is one and a-half inches, with obliquely curved transverse striæ, rather than ridges, and resembles in general appearance De Koninck's figure ‡ of *O. striatum*, J. Sby., although the longitudinal striation visible on that fossil is not preserved in the present specimen.

Fragmentary remains of the genus are met with in the Star River Series; one form, without traces of external ornament, possessed distant septa; another had close, fine, thread-like, waved striæ; whilst in a third the ornament was similar, but less waved, coarser, and separated by interspaces with a breadth equal to rather more than the thickness of the striæ.

The Mount Britton Beds have yielded the only specimen yet seen in the round (Pl. 39, fig. 10), showing portions of five chambers, one and three-quarters of an inch long, and one inch in diameter. The chambers are about a quarter of an inch in depth, with a circular section. The specimen is denuded of the test.

In the Collection made by Mr. De Vis are two other Orthoceratites. One consists of seven narrow chambers in a space of twelve-sixteenths of an inch, to some extent flattened like De Koninck's figure of his *Camero-ceras Phillipsii*,§ with a vertical linear depression in the middle line. It is ten-sixteenths of an inch wide.

The other species is represented by two narrow, small shells, about the dimensions of *O. Martinianum*, De Kon.,|| but very delicately transversely striated. They measure two and two and a-half inches respectively, four-sixteenths wide at the distal end, tapering to a fine point. The septa are about one-sixteenth of an inch apart.

*Loc. and Horizon.* Gympie (*R. L. Jack*)—Gympie Beds; Corner Creek, Great Star River (*R. L. Jack*)—Star Beds; Richards' Homestead, three miles south-west of Mount Britton Township (*R. L. Jack*)—Middle or Marine Series of the Bowen River Coal Field; Rockhampton District ¶ (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

\* Dames and Keyser's Pal. Abhandlungen, 1889, i., Heft 1, t. 4, f. 8.

† See note, p. 199.

‡ Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 341, t. 24, f. 2.

§ *Ibid.*, p. 341, t. 24, f. 1.

|| *Ibid.*, p. 343, t. 24, f. 3.

¶ See note, p. 199.

Genus—*GYROCERAS* (Von Meyer), De Koninck, 1844.

(Descrip. Anim. Foss. Terr. Carb. Belgique, p. 530.)

*GYROCERAS DUBIUS*, *sp. nov.*, Pl. 41, fig. 12.

*Sp. Char.* Entire shell unknown; terminal portion of body-whorl produced and curved rather irregularly; sides convex, but depressed; back or ventral surface concave, bounded by a keel on each side; dorsal surface apparently broad, and not acute, surface bearing sharp, crest-like, obliquely transverse, somewhat semicircular ridges or costæ.

*Obs.* This interesting fragment would seem to represent a form resembling *Gyroceras aigoceras*, Münster,\* but with a different curvature, and sharper and more prominent costæ. At the same time the very strong likeness it bears to the terminal portion of the shell in *Ophidioceras*, must not be overlooked. The enlargement at the distal end probably represents the aperture, and in this case the resemblance becomes still more apparent.

A possible relation with the previous *Nautilus ? ammonitiformis*, has presented itself for consideration, and would have been entertained had it not been for the great difference between the breadth of the last chamber of the former and that of the present fossil, which renders it almost impossible for the two to be portions of one species. At the same time the irregular curve of *G. dubius* is unlike the symmetrical outline of *G. aigoceras*, but only the acquisition of more complete specimens can satisfactorily explain the relation of these obscure and indifferently preserved shells.

*Loc. and Horizon.* Rockhampton District † (*The late Rev. J. E. Tenison Woods*; Colln. De Vis)—Gympie Beds.

Family—GONIATITIDÆ.

Genus—*GONIATITES*, De Haan, 1825.

(Mon. Ammonites et Goniates, p. 39.)

*GONIATITES MICROMPHALUS*, Morris.

*Bellerophon micromphalus*, Morris, Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 238, t. 18, f. 7.

„ Dana, Geology Wilkes' U. S. Explor. Exped., p. 708, Atlas, t. 10, f. 6.

*Goniates micromphalus*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 339, t. 24, f. 5.

„ „ Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 304.

*Obs.* Two specimens of this species have been collected by my Colleague, both of them casts, without any trace of shelly matter remaining. The form of the shell and character of the umbilicus in the Bowen River Coal Field specimens correspond quite well with Professor Morris's description and figures, but the depth of the body-whorl near the mouth is not so great, although the disparity is greater in one of our specimens than in the other. However, this need be dwelt on less, since Prof. Dana has given such a figure ‡ of *G. micromphalus*, and on examining those in the Strzelecki Collection the same aperture was found to exist in some of the specimens there.

*Loc. and Horizon.* Head of Pelican Creek, near Mount Divlin, Bowen River (*R. L. Jack*)—Middle or Marine Series, Bowen River Coal Field.

\* Ann. Mus. R. Hist. Nat. Belgique, 1880, v., t. 32, f. 4 (Faune du Calcaire Carbonifère de la Belgique, Pt. 2.)

† See note, p 199.

‡ Geology Wilkes' U. S. Explor. Exped., Atlas, t. 10, f. 6a

GONIATITES, *sp. ind.*, Pl. 15, fig. 5.

*Goniatites, sp. ind.*, Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880, v., p. 305.

*Obs.* A second species is present in the Bowen River Beds, differing from *G. micromphalus* in having a very much sharper back. It appears to be nearer to *G. striatus*, Dana,\* than to Morris's species. A sharp-backed Goniatite has also been found at Gympie. It is much sharper and narrower than *G. micromphalus*, and is interesting from its locality.

*Loc. and Horizon.* Rosella Creek, two miles above Havilah Paddock (*R. L. Jack*). This is an important fossil, as it is another of those occurring in a marine band in the Upper or Fresh Water Series. Gympie (*R. L. Jack*).

GONIATITES PLANORBIFORMIS, *sp. nov.*, Pl. 41, fig. 9.

*Sp. Char.* Whorls numerous, at least six, increasing in size very slowly and in one plane, coil-like or planorbiform, very slightly convex; no umbilicus visible; test not preserved, but surface plain in casts; lobes and saddles nearly equal, but the latter rather the more pointed; two chambers occupy about the space of seven millimetres.

*Obs.* The preservation of this shell only in the form of casts renders it very difficult to assign it reliable characters, but the chief and striking point is its very compactly coiled and planorbiform aspect. The largest specimen observed measures one and a-half inches in diameter, the whorls increasing in size very slowly.

The septa are very rarely seen, the specimens having very much more the appearance of a tightly and flatly coiled Euomphaloid shell than a Goniatite. The species is of the type of, and nearly allied to, *Goniatites clymeniaformis*, De Koninck,† but the body-whorl of the latter is much broader than in ours. A somewhat similar shell is *Euomphalus sancti-sabæ*, Roemer,‡ from the Carboniferous of Texas, which may as well be a Goniatite as a Euomphalus, for all the evidence there is to the contrary.

The sutural convolutions do not well correspond with any of the recognised groups of Goniatites, but they approach nearest to those of the subdivision *Carbonarii* in Beyrich's classification. Neither have I been able to locate this species in either of the sections proposed by the Brothers Sandberger on similar anatomical structure.

*Loc. and Horizon.* Lake's Creek, near Rockhampton (*The late James Smith*); Rockhampton District § (*The late Rev. J. E. Tenison Woods*; Colln. De Vis)—Gympie Beds.

GONIATITES, *sp. ind.*, Pl. 15, figs. 14 and 15.

[Compare *G. striatus*, J. Sby., Min. Con., 1814, i., p. 115, t. 53, f. 1.]

*Obs.* A moderately large Goniatite, in a bad state of preservation, but much larger and stouter than *G. micromphalus*, was obtained by the late Mr. James Smith. It is viewed partly in the round, partly in section, from the manner in which the stone has been fractured. It clearly belongs to the group of the above species, the external ornament, so far as preserved, corresponding with that of the type of *G. striatus* in the Sowerby Collection.|| I think it is even possible to recognize, in places, the minutely delicate cross-bars between the regular spiral raised lines of the surface. The course of the septa is identical with that of Sowerby's species, and strong varices of growth are also here and there visible across the back of the specimen. The septa apparently have four folds, sharp and angular. The umbilicus is small and regular as in the type and all the volutions hidden.

\* *Loc. cit.*, f. 5a and b.

† Faune Calc. Carb. Belgique, Pt. 2, 1880, t. 49, f. 12.

‡ Kreidebildung von Texas, 1852, t. 11, f. 5a and b.

§ See note, p. 199.

|| Natural History Museum, London.

Mr. W. H. Rands has found a second specimen, convex and round, and generally like the above. It has a small umbilicus, but the other characters are obscure.

*Loc. and Horizon.* Training Wall Quarries, Rockhampton (*The late James Smith*); Hawkins' Gully, Kariboe Creek, Kroombit Diggings, Port Curtis (*W. H. Rands*)—Gympie Beds.

## Sub-Kingdom—VERTEBRATA.

### Class—PISCES.

### Order—CHONDROPTERYGII.

#### Family—COCHLIODONTIDÆ.

*Genus*—*DELTODUS*, *L. Agassiz*, 1859, M.S.

(Enniskillen Collection.)\*

*DELTODUS* ? *AUSTRALIS*, *sp. nov.*, Pl. 39, fig. 11.

*Sp. Char.* Oblong-triangular, insensibly flattening towards the broader or anterior end. The outer side is thickened, and obtusely rounded, the outer or base thinner and sharper. Anterior margin gently rounded, the posterior end gradually acuminate, and more or less obtusely so. The surface gradually decreases towards the basal and anterior margins, and is traversed almost medianly by a rather curved, wide, deep sulcus, narrower at the basal than the outer end, and followed in the direction of the anterior end, by two other parallel and indistinct depressions. Structure open and porous. Section semi-circular, abruptly so on the outer side.

*Obs.* With the exception of the *Tomodus convexus*, Ag., figured by Prof. De Koninck, from the Permo-Carboniferous of New South Wales, this is the only Cochliodont known to me from this portion of the Australian Palæozoic rocks. I do not feel at all certain that the reference to *Deltodus* is a correct one, but in the unsatisfactory state of our antipodean scientific libraries, I am unable to make a more exact determination. If a species of this genus, it approaches *D. aliformis*, McCoy, but is much more regular in outline, and lacks the contracted posterior end of that species.

*Loc. and Horizon.* Rockhampton District † (*C. W. De Vis*; Colln. De Vis)—Gympie Beds.

### Order—GANOIDEI.

#### Family—PALÆONISCIDÆ.

Remains of a Palæoniscid fish have been presented to the Mining and Geological Museum, Sydney, by Mr. C. T. Musson, F.L.S. "from a ridge half a mile from and to the north of the Bogantungan Railway Station," Drummond Range (= Star Beds).‡ From the same locality the late Mr. James Smith made a large collection of fish-remains, which I have not yet had an opportunity of examining.

Mr. Rands has also recently discovered the remains of a fish in the Star Beds near Lornesleigh Station.§ It certainly belongs to this family, and, so far as the want of the head will permit an opinion to be formed, it appertains to the genus *Palæoniscus*.

\* *Fide* Morris and Roberts, *Quart. Journ. Geol. Soc.*, 1862, xviii., p. 100; defined, Newberry and Worthen, *Illinois Geol. Report*, 1866, ii., p. 95; A. Smith Woodward, *Cat. Foss. Fishes Brit. Mus.*, 1889 Pt. 1, p. 195.

† See note, p. 199.

‡ Etheridge, junr., *Records Geol. Survey N.S. Wales*, 1890, Vol. ii., Pt. 2, p. 71.

§ Report on the Cape River Gold Field. Brisbane: by Authority: 1891.

## INSERTÆ SEDIS.

## TRACKS AND MARKINGS.

*ARENICOLITES*, Salter,\* Pl. 8, figs. 2 and 3.

*Obs.* The late Mr. James Smith found in the Stanwell Building-stone, a number of vertical tubes, with trumpet-mouth-shaped openings, the resemblance of which to Salter's *Arenicolites* he called attention to on the labels of his specimens.

The tubes are vertical, straight, and at right angles to the bedding of the ferruginous sandstone in which they occur, sometimes single, at other times in pairs. When double they are parallel to one another, one end of each tube expanding into a trumpet-mouth-shaped aperture. The walls, internally appear to have been concentrically ridged, when the sediment with which they have been filled is removed. The latter is of a finer consistency than the surrounding matrix, and of a different shade of colour.

The tubes of the Stanwell Building-stone are much larger than those of the English Cambrian rocks, described by Salter, but they more closely resemble, both in size and appearance, others from the Durness Limestone,† figured by the same Author.

The nature of these burrows is extremely doubtful, but I do not believe in the theory which ascribes them to the action of worms. That they are the burrows of some animal is unquestionable, but an explanation should be looked for amongst the Mollusca rather than the Annelida. Very similar burrows are produced, for instance, by the Razor-fish (*Solen*). They do not partake of the nature of those elongated tubes for which Prof. James Hall suggested the name of *Scolithus*.

*Loc. and Horizon.* Stanwell Building-stone, near Rockhampton (*The late James Smith*)—Gympie Beds.

## BURROWS. ?

Pl. 8, fig. 4; Pl. 39, fig. 1; Pl. 44, figs. 15-18.

*Obs.* I am indebted to Mr. C. W. de Vis, of the Queensland Museum, for the peculiar bodies about to be described. They occur in a shale which has undergone much alteration, and become exceedingly hard, brittle, and cherty, and they further present a different appearance as they are seen in this matrix, or its weathered and semi-decomposed equivalent. I have not been able to absolutely detect the bedding in this rock, but appearances point to these markings being parallel to it, or, perhaps, cutting it at an oblique angle. In the decomposed material they present the appearance of straight or slightly-curved tubes, which dilate somewhat at their distal ends, or enlargements may take place during the course of the burrow. These passages are filled with a material resembling the surrounding matrix in colour and consistence, but broken up into segments, or divided into a series of infundibuliform divisions after the manner of the chambers of a multilocular shell. In this condition these curious remains appear under two aspects—First, as infilled tubes preserved in the round, each segment fitting into its neighbour, and weathering out separately one from the other: Secondly, when the surface of the matrix has been removed by weathering, the outline of the tube is destroyed, but the segments are left in relief as a number of disjointed and apparently moniliform bodies, and in this condition resembling many tracks, which have from time to time been erroneously referred to worms and other improbable organisms.

\* Quart. Journ. Geol. Soc., 1859, xiii., p. 204.

† Loc. cit., 1859, xv., t. 13, f. 29 and 30.

On the weathered surfaces of the hardened and undecomposed shale, the remains of these burrows present a most peculiar appearance, all traces of the tube having disappeared, whilst the infilling portions, often, in this case, of a different colour to the surrounding matrix, are left as a series of more or less disjointed, infundibuliform stains. This is the longitudinal aspect, but when seen in section the circular outline is quite apparent, and as both longitudinal and transverse sections are visible on the same specimen no doubt can be entertained of their connection with one another. In our present limited knowledge of the nature of the numerous tracks and markings found on the surfaces of the older rocks, it is difficult to offer a reliable explanation of these bodies. It has been customary to make the Annelida a kind of refuge for the destitute in such cases, but the writings of the late Prof. Ferdinand von Roemer, Mr. Nathorst, and others have probably given the death-blow to this loose method of generalisation. A general epitome of the subject will be found in an article by Prof. H. A. Nicholson and the Writer,\* but no better explanation of how a large number of these tracks are formed has been offered than the lucid and exhaustive description by the late Albany Hancock of vermiform markings in the Carboniferous Limestone of the North of England.† This eminent Naturalist has suggested the analogy of his vermiform markings to the burrows of certain Amphipod Crustaceans, named *Kröyeria arenaria*, Bate, and *Sulcator arenarius*, made in shore-sand under his own eyes. Speaking of certain of the fossil-tracks, he says:—"Full-sized specimens are half an inch wide, and are composed of a series of nodules, which give them an articulated appearance. The nodules, which vary a little in size, are usually about half an inch long, and are not very symmetrically or regularly formed. Consequently the surface has generally an imperfect or worn character. The extremities are not often seen; they are abruptly and irregularly rounded."

These remarks were supplemented by the following:—"The specimens . . . are characterised, as we have seen, by a remarkable nodulous or articulated appearance which has been supposed to indicate the presence of rings of some Annelide; and, indeed, were it not for the light derived from the Crustacean tracks on our shores, it would not be easy to conjecture a more plausible explanation. We have seen, however, that a variety of the track of *Kröyeria arenaria* has the ridge of sand thrown up, broken into nodules, giving to it a beaded character. This, on a small scale, has a considerable resemblance to these nodular forms. But a much nearer approximation is found with nodulous tracks of *Sulcator arenarius*. . . . It may therefore be assumed that the animal which made these nodulous tracks, like our small Crustacean, pushed along in its path, step by step, resting awhile after each advance, but that, instead of moving in each horizontal plane, it alternately rose and sunk a little; consequently, a series of nodules was produced, and the track acquired its peculiar articulated appearance. This explanation is strengthened not a little when we look at the side view of the cast of this track. The nodules are then distinctly observed to be imbricated, and to pass, very much inclined, right through the substance from top to bottom."

Without implying that the Rockhampton markings are produced by Amphipods, these quotations are simply given to show that it is not necessary to call in the aid of the Annelida for their explanation. The only Crustaceans known to occur in these beds are Trilobites, but the tracks are not such as have been hitherto ascribed to these animals. Other organisms are capable of causing such raised tracks, as evinced by

\* Mon. Sil. Foss. Girvan in Ayrshire, 1880, Pt. 3, p. 304.

† "Remarks on certain Vermiform Fossils found in the Mountain Limestone Districts of the North of England." *Ann. and Mag. Nat. Hist.*, 1858, ii., p. 443; *Trans. Tyneside Nat. Field Club*, 1858, iv., Pt. i., p. 17.



the trail of the common British *Purpura*, figured by Professor H. A. Nicholson and the Writer.\* It is therefore clear that, between the Crustacea and Mollusca, there is a wide field for speculation as to the origin of these peculiar burrows.

In their disjointed nature, they bear considerable resemblance to the so-called Carboniferous worm-track, elevated into a genus by the late Mr. G. Tate, of Alnwick, under the name of *Eione*.† When seen in a weathered disjointed state (Pl. 8, fig. 2) there is a very marked similarity to his *Eione moniliformis*.‡

In the memoir quoted above, Mr. Handcock speculated as to his tracks or burrows being made by Trilobites, and appeared to favour such an explanation. Those under description, however, would not be large enough to accommodate the *Phillipsia* and *Griffithides*, hitherto found in the Permo-Carboniferous rocks of Queensland.

Finally, it may be pointed out that these burrows appear almost identical with the so-called worm-tracks from the black slates of the Happy Valley, north of Nelson, New Zealand, and figured in the account of the "Novara" Expedition.§

*Loc. and Horizon.* Athelstane Range, near Rockhampton (*The late James Smith*); Rockhampton District || (*O. W. De Vis*; Colln. De Vis)—Gympie Beds.

F.

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\* Mon. Sil. Foss. Girvan in Ayrshire, 1880, Pt. 2, p. 317, f. 11.

† The Geology of Beadnell, in the County of Northumberland, with a description of some Annelids of the Carboniferous Formation. *Geologist*, 1859, ii., p. 59.

‡ *Loc. cit.*, p. 62, t. 2, f. 6.

§ Reise Oester. Fregatte "Novara," 1857-59, Geol. Theil., Bd. i., 2 Abth., 1865, t. 7, f. 5.

|| See note, p. 199.

## CHAPTER XXIII.

### THE TRIAS-JURA SYSTEM.

#### LOWER (BURRUM) FORMATION.

On a higher horizon than the Permo-Carboniferous System and on a lower than the Ipswich Formation, the great series of coal-bearing rocks known as the Burrum Coal Field is met with. This Coal Field extends along the eastern coast line, from Point Cartwright on the south at least to Littabella Creek on the north, and stretches inland for an average distance of twenty-five miles. Its area may be roughly estimated at three thousand square miles.

Divided from the main area of the Burrum Coal Field by a mass of granite, a small area supposed to belong to the same period is met with at the south end of Rodd Bay.

Still another area, believed to be of the same age, occurs in the Valley of the Styx, at the southern end of Broad Sound.

The Burrum Formation has been traced southward to near Point Cartwright, where it is no great distance from the northern end of the Ipswich Coal Field. The two coalfields are separated by a protrusion of slaty rocks, which may be supposed to belong to the Gympie Formation. It is to be regretted that the relation of the two fields cannot be seen at this point. All that can be stated is that they apparently are characterised by a distinct fauna and flora.

The Burrum Coal Field is characterised by a very meagre flora and a fauna represented only by one species of *Corbicula* and one of *Rocellaria*. The latter are both new species. Of the flora four species occur also in the Ipswich Formation, while six other species are confined (so far as our Collections show) to the Burrum Formation.

Mr. Gregory referred to the finding of *Glossopteris* above the Upper or Beaufort Seam of Coal. Mr. Rands observed in his Report of 1886 that he had failed to find *Glossopteris*. In his Annual Report for 1886, however, he stated, "I have found several specimens of *Glossopteris Browniana* amongst stone from the Briton Shaft." My Colleague, however, is not satisfied that *Glossopteris* really occurs in these beds. Such of Mr. Gregory's and Mr. Rands' specimens as have come under his notice he regards as *Tæniopterid* plants.

The whole country covered by this formation is low and flat, and is characterised by a poor soil and stunted vegetation. The latter circumstance is, however, due to a thin covering of a more recent formation which overlies it unconformably.

Distinct from the thin covering and certainly older, is the group of fossiliferous sandstones known as the Maryborough Beds, which are placed on the same horizon as the Desert Sandstone (*which see*). The relation of the Maryborough Beds to the Burrum Beds, although obscure, is believed to be that the former rest unconformably on the latter, and that a fault (which, however, is not seen) must account for the fact that the lowest of the Maryborough Beds, after dipping, do not rise on the other side. Their apparent conformability to the Burrum Beds *must* be deceptive, as even if the latter were equivalent to the uppermost members of the Ipswich Formation, the whole of the Rolling Downs Period is unrepresented. Mr. Rands sends me (in a letter dated 16th September, 1889) the Section reproduced in Plate 46, fig. 3, explanatory of this relation.

The Burrum Beds themselves lie unconformably on the Gympie Beds (Permo-Carboniferous), as is shown by the Section, Pl. 50, fig. 2, taken from a Report by Mr. Rands,\* who remarks:—

"The actual junction of the Gympie Beds with the [Burrum] Coal Measures is concealed by sandy country. At the southern boundary of the Coal Measures the relation of these beds to one another is better seen on the Maryborough and Gympie Railway, about two miles south of the Curra Station. There is a hard porphyritic rock containing crystals of felspar, hornblende, and mica, in the cutting fifty-one miles from Maryborough. Laminated sandstones and shales belonging to the Burrum Beds occur in a cutting fifty and a-half miles from Maryborough. They dip N.W. at 6°, and overlie the porphyry, which here is more of the character of a white felsite. In the cutting at fifty-one and a-half miles from Maryborough, white felsite occurs again, while, ten chains further south, the upper shales of the Gympie Series come in, dipping E. 40° N. at 45°. A small 'sheet' of felsite is seen in these shales, about two chains further south, and a larger sheet of it about one and a-half miles south of that again. The Gympie shales do not appear to have been baked or altered by this rock, and I am of opinion that the felsite is interbedded with the shales. But supposing the felsite to be intrusive in the shales, it was intruded before the Burrum Beds were deposited, otherwise we should find it intruding these beds also, which is not the case. In either case, therefore, the unconformability of the Burrum and Gympie Beds is manifest."

Within certain limits, therefore, the age of the Burrum Beds is fixed by stratigraphical evidence. They are newer than the Permo-Carboniferous, and older than the Upper Cretaceous.

On the western edge of the field the strata, which in the type district are unaltered, and but little disturbed, become inclined at high angles, and altered into micaceous slates, which are veined with quartz, and finally rest upon granites.

Prior to the date (1836) of my "Handbook of Queensland Geology," the chief sources of information regarding the Burrum Coal Field were Mr. A. C. Gregory's two Reports,† and passages in the Rev. J. E. Tenison Woods' "Coal Resources of Queensland."‡ Since that date, Mr. Rands has furnished two Reports,§ dealing with the stratigraphical geology of the series in detail. The description which follows is mainly compiled from these writings, with such additions as I have been able to make from a limited personal knowledge of the district.

In the immediate neighbourhood of the town of Howard, which is the centre of mining operations, the strata dip with great regularity to the north-east, at an average angle of about 12°, and do not appear to be disturbed by faults of any magnitude. From his surveys, Mr. Rands has compiled the following section:—

								Ft.	in.
Brown and grey sandstone	...	...	...	...	...	...	...	40	0
Shales with beds of sandstone	...	...	...	...	...	...	...	66	0
BRIDGE SEAM	{	Coal	...	...	...	...	...	2	7
		Shale	...	...	...	...	...	5	0
		Coal	...	...	...	...	...	3	0
Carried forward	...	...	...	...	...	...	...	116	7

\* Report on Tiaro District: The Coal Measures, &c. Brisbane: by Authority: 1890.

† On the Geology of part of the Districts of Wide Bay and Burnett. Brisbane: by Authority: 1875. And Report on the Burrum Coal Field. Brisbane: by Authority: 1870.

‡ Brisbane: The Government Printer, 1883.

§ Report on the Burrum Coal Field. Brisbane: by Authority: 1886. And Report on Tiaro District: The Coal Measures, &c. Brisbane: by Authority: 1890.

										Ft.	in.
Brought forward	...	...	...	...	...	...	...	...	...	116	7
Shales with thin Coal-seams	...	...	...	...	...	...	...	...	...	220	0
Coal, LAPHAM or TORBANELEA SEAM	...	...	...	...	...	...	...	...	4ft. 11in. to 2	0	0
Shales ...	...	...	...	...	...	...	...	...	...	35	0
Coal, BURRUM SEAM	...	...	...	...	...	...	...	...	...	3	7
Shales with thin beds of sandstone and a thin seam of Coal	...	...	...	...	...	...	...	...	...	150	0
Coal, WATSON'S SEAM	...	...	...	...	...	...	...	...	...	4	0
Shales ...	...	...	...	...	...	...	...	...	...	70	0
Sandstone	...	...	...	...	...	...	...	...	...	150	0
Coal ...	...	...	...	...	...	...	...	...	...	1	6
Sandstone and Shale	...	...	...	...	...	...	...	...	...	30	0
Coal, said to be	...	...	...	...	...	...	...	...	...	2	6
Sandstone	...	...	...	...	...	...	...	...	...	14	0
Coal, NORTH HARTLEY SEAM	...	...	...	...	...	...	...	...	...	4	2
Sandstone	...	...	...	...	...	...	...	...	...	88	0
Coal, three thin seams, 2 to 4 inches thick	...	...	...	...	...	...	...	...	...	0	4
Sandstone	...	...	...	...	...	...	...	...	...	111	8
Coal, GLENESK SEAM	...	...	...	...	...	...	...	...	...	1	8
Total	...	...	...	...	...	...	...	...	...	1,015	0

That the above form only a small portion of the total thickness of the Coal Measures is evident from the map attached to Mr. Rands' Report. A copy of the map on a reduced scale is given in Pl. 47. The strata continue to rise in the same direction and at the same angle for at least two and a quarter miles up the streams which make sections to the south-west, before any inversions of dip or want of evidence would lead us to doubt that we are crossing the successive outcrops of similar strata. Probably the total thickness of strata beneath the Glenesk Seam is not less than three thousand feet, or, say, four thousand feet of strata below the horizon of the Bridge Seam.

It may be mentioned that there are some discrepancies between Mr. Gregory's and Mr. Rands' readings of the section; thus Mr. Gregory gives the distance between the Lapham and Burrum Seams as fifty five and Mr. Rands as thirty five feet. Between the Burrum and Watson's Seams, Mr. Gregory gives one hundred and Mr. Rands one hundred and fifty feet; and between Watson's and the North Hartley Mr. Gregory gives five hundred and Mr. Rands two hundred and sixty eight feet. I presume that Mr. Rands, being in possession of later information, is more correct in these details. A bore at Torbanelea, quoted in Mr. Rands' Annual Report for 1886, gives the position of the Watson Seam as one hundred and fifty feet above the Burrum.

Mr. Rands gives the following particulars regarding the Torbanelea Mine:—

"The pit is sunk through the Lapham or Torbanelea Mine down to the Burrum Seam, cutting the former at eighty five feet and the latter at one hundred and ten feet. Work was at first started at the Lower or Burrum Seam, but it has been abandoned for the time being to work the Lapham Seam, which is reached by a crosscut put in from the former. The Lapham is a harder and better coal, especially for gas-making purposes. The Burrum Seam is here three feet eleven inches thick, with a band of shale seven inches thick. The roof is a grey shale and is fairly good. The coal is friable.

"The Lapham Seam is thicker, and is a more solid and brighter coal. It is six feet two inches in thickness, including a band of black carbonaceous shale one foot three inches thick in the middle. The roof is of black shale. Experiments conducted at Melbourne prove this to be a good steam coal. Two tons of coal evaporated 3,900 gallons of water, whereas two tons of the best Newcastle (N.S.W.) coal evaporated

only 3,200 gallons, or in a ratio of  $8\frac{1}{2}$  to  $7\frac{1}{2}$ . The manager of the Maryborough gas-works gave me the following returns from twenty months' actual work with the coal from this seam:—

Gas ... ..	10,200 cub. ft. per ton of Coal.	Candle power, 14·73.
Coke ... ..	1,460 lb.   "   "	(65 per cent.)
Tar ... ..	10·5 gallons   "   "	
Ammoniacal liquor ...	16·0   "   "   "	

"The Queensland Coal Company's shaft gave the following sections:—

	Ft.	in.
Coal ... ..	0	4
Black shale ... ..	0	6
Coal ... ..	0	3
Fireclay ... ..	2	8
Sandstone with ironstone bands ... ..	7	8
Light clay ... ..	1	11
Coal ... ..	0	9
Black shale ... ..	0	6
Hand band of fireclay ... ..	4	7
Shale and ironstone... ..	4	2
Shale with ferns ... ..	1	8
Sandy clay ... ..	3	0
Coal ... ..	0	3
Fireclay and bands of ironstone ... ..	6	10
Dark coaly shale and ironstone ... ..	5	1
Black shale ... ..	2	9
Coal ... ..	0	3
Fireclay ... ..	6	11
Striped sandstone and ironstone ... ..	4	5
Striped sandy shale and ironstone ... ..	7	2
Shale ... ..	3	4
Coal ... ..	0	6
Shale ... ..	1	1
Coal ... ..	1	1
Shale ... ..	1	6
Coal ... ..	0	11
Fireclay ... ..	3	6
Coaly shale ... ..	1	0
Shales... ..	11	7
Coal ... ..	0	9
Fireclay ... ..	1	3
Fireclay with nodules ... ..	2	6
Total ... ..	234	8

"The seam being worked varies very much in thickness. In the north-westerly level, at four hundred and thirty feet from the pit bottom, it measures—

	Ft.	In.
Shale... ..	0	0
Coal ... ..	0	4
Shale ... ..	0	4
Coal ... ..	1	6
Shale ... ..	0	7
Coal ... ..	1	7
Fireclay ... ..	0	0

"In the same level, seven hundred and fifty feet from the pit bottom, the coal measures three feet six inches, without any intervening shale. The same seam was worked in Whitley's shaft."

Mr. Rands conjectures that the seam worked in the Company's mine may be the Lapham Seam.

The Howard, or Beaufort and Howard Seam, "four feet five inches thick, with only a thin band of shale," was worked from shafts fifty feet in depth. The seam "lies probably above the seam worked by the Company" [Rands]. Mr. Gregory places the Beaufort Seam thirty feet above the Lapham.

The Glenesk Seam has been worked from a shaft one hundred feet in depth. It is from eighteen inches to two feet in thickness.

#### ANALYSES.

—	Water.	Volatile Hydrocarbons.	Fixed Carbon.	Ash.	Sulphur.	Specific Gravity.	Coke.
1. Whitley's Shaft (Q. C. Co's Seam)	...	26.6	68.4	5.0			
2. Beaufort Seam (Beaufort Shaft)...	...	31.5	64.0	4.5			
3. Burrum Seam (outcrop) ...	...	29.8	62.2	8.0			
4. Q. C. Co's. Seam ... ..	2.50	30.35	64.30	2.50 (grey)	0.35	1.24	66.80
5. Lapham or Torbanelea Seam (Torbanelea Colliery, bottom coal)	2.00	28.00	61.60	8.00 (grey)	0.40	1.31	69.60
6. Ditto (top coal) ... ..	2.25	29.15	66.50	2.10 (grey)	...	1.26	68.60
7. Burrum Seam (Torbanelea Colliery)	2.75	28.00	66.55	3.25 (reddish)	0.45	1.27	68.60
8. Torbanelea Seam ... ..	0.10	27.00	69.96	2.04	0.90		

Analyses Nos. 1, 2, and 3 are by Mr. Gregory; Nos. 4, 5, 6, and 7, by Mr. Rands; and No. 8 by Dr. D. Marsh, quoted by Dr. J. R. M. Robertson in a Report on the Torbanelea Mine.

On the coal-seams of the Burrum field generally, Mr. Rands remarks:—

"The analyses of the coals from the Burrum would show that, with reference to the volatile hydrocarbons, of which, of course, a high percentage is necessary for gas-making purposes, they are not quite as good as the Newcastle coals (New South Wales). Fourteen samples of the latter averaged 37.55 per cent. of volatile hydrocarbons, including water; while the average of seven samples from Burrum is 31.5, that is also taking the hydrocarbons and water together.

"The ash, which represents so much of worse than useless matter, is by no means high; the highest result being 8 per cent., and lowest 2.1 per cent., the average being 4.6 per cent., as against an average of 4.97 per cent. in the Newcastle coal (New South Wales). It should be mentioned that the Burrum samples are from shallow depths, where the ash is generally higher. The ash is of a very light red or grey colour.

"The sulphur, averaging 0.4 per cent. in the three samples in which I determined it, is very low indeed, and the coal will compare favourably in that respect with coal from any part of the world. Unfortunately, however, in all the analyses of the Burrum coals hitherto made, the sulphur has not been determined. The percentage of this constituent is most important in coals used for gas-making. Freedom from sulphur, too, is a great advantage in many metallurgical processes.

"The cokes from the Queensland Collieries Company's seam, the Lapham or Torbanelea seam, and the Burrum seam, are all good, coherent, dense cokes; that from the first-named being the densest. The Burrum coal is not so good a steam coal on account of its tenderness, it being very easily broken up by attrition."

Several seams of coal are seen in Cherwell Creek, about four miles to the north-west of Howard, as well as in the Isis and Gregory Rivers.

South of Maryborough the same formation has been mapped and reported on by Mr. Randa. It is separated from the Permo-Carboniferous rocks by a line running south-east from the heads of Ooramera Creek to the Mary River, south of the mouth of Hookey Creek, and thence eastward to Curra Creek. From Curra Creek the line runs north-eastward till it bends round the spurs of Mt. Goomboorian, on which the Neerdie Antimony Mines are situated. Thence the line runs south-south-east to the coast at Point Cartwright. The strata are disposed in a trough, of which the synclinal axis, roughly speaking, coincides with the line of the Maryborough and Gympie Railway.

In the Tiaro District, the formation is much more disturbed by faults and intrusive rocks than in the Burrum District. The direction and degree of dip are seldom the same over any large area. In many places dykes and masses of intrusive rocks come up through and disturb the coal strata. The Kannagan Range, near Kilkivan Junction, consists entirely of felsite-porphry. An intrusive mass of hornblende and feldspar-porphry occurs near Tiaro. Near Aurora Plantation a large dyke of porphyritic rock forms a bar across the Mary River, and a similar rock occurs in a railway cutting north of Mungar. A volcanic agglomerate is seen on the Railway twenty three and a half miles from Maryborough. A mass of micaceous granite occurs on the eastern slope of Mt. Bopple. The granitic mass of Teebar abuts to the north against both the Burrum and the Gympie Beds.

The strata consists of conglomerates, sandstones, shales and clays, with beds of coal, and are, on the whole, very much similar to those of the Burrum District. They are full of plant-remains, which, however, are generally not well preserved. The dip of the strata is generally very high, varying from  $25^{\circ}$  to  $48^{\circ}$ .

In Bull's Selection (No. 1537), near Gunalda, a seam of bright steel-grey anthracitic coal, eighteen to twenty inches thick, was cut in a shaft at a depth of forty one feet. The coal and other strata dip W.  $20^{\circ}$  S. at a low angle towards the felsite of the Kannagan Range. The shales have been baked, and the greater part of the hydrocarbons driven from the coal by the felsite.

In Selection 1767, two and a half miles above the junction of Munna Creek with the Mary River, the following strata dip at  $11^{\circ}$  to N.  $30^{\circ}$  E. :—

												Pt.	in.
Shale	...	...	...	...	...	...	...	...	...	...	...	1	0
Bright bituminous Coal (Top Seam)	...	...	...	...	...	...	...	...	...	...	...	2	8
Black coaly shale	...	...	...	...	...	...	...	...	...	...	...	2	1
Bright bituminous Coal with a few thin bands (Bottom Seam)	...	...	...	...	...	...	...	...	...	...	...	3	0
Black and brown shales	...	...	...	...	...	...	...	...	...	...	...	3	3
Coal and shale mixed	...	...	...	...	...	...	...	...	...	...	...	3	0

In his "Report on the Coal Deposits of West Moreton and Darling Downs," Mr. Gregory gives the following analysis of coal from "Miva Seam, Mary River":—

Volatile in coking	...	...	...	...	...	...	...	...	...	23.6
Fixed carbon	...	...	...	...	...	...	...	...	...	61.0
Ash	...	...	...	...	...	...	...	...	...	15.4
										<hr/>
										100.0

Coke, 76.4; Carbon in coke, 80; Ash in coke, 20.

From some expressions in his "Report on part of Wide Bay and Burnett Districts," I infer that this Miva Coal is the same as that in Munna Creek.

On Tanyalba Creek, about a mile and a half north of the last section, are two thick seams of impure coal, as in the following sections:—

	Ft.	in.
Nodular clay-ironstones and shales	...	...
Coal (very impure)	7	4
Sandstone and shale	67	5
Coal (impure)	5	9
Black carbonaceous shales	7	0
Alternate bands of Coal and shale	40	5

In Jones' Selection, No. 1311, the following dip W. 10° S. at 40°:—

	Ft.	in.
Brown Sandstone	23	0
Clay	0	6
SEAM I.—		
Bright hard Coal	1	11
Black coaly shale	0	2½
Bright hard Coal	1	4½
Fireclay	0	8
Coal	0	9
Fireclay	3	9
Coal	0	6
Clay	0	4
Coal	0	9
Clay	0	7
Coal	0	7
Clay	0	9
SEAM II.—Coal	3	6
Sandstone	1	0
Clay and black shale	3	0
SEAM III.—		
Coal	0	2
Clay band	0	2
Coal	1	2
Shale	1	4
Grey sandstone	0	11
SEAM IV.—Coal	1	6
Sandy shale with two thin beds of Coal	19	4
Hard brown sandstone	6	0
Black shale	1	9
SEAM V.—Coal	3	0

Two chains higher up the Creek, a three feet seam of coal is said to be visible in a waterhole. At the northern boundary fence of the Selection (still higher up the Creek), a hard bright coal-seam of good quality, three feet thick, can be seen in a waterhole. It is probable that this seam is the same as No. 1 in the above section.

In Selection 1737 (Sorensen's) is a seam of coal two and a half feet thick, with sandstone above and below.

On the western slope of Mount Bopple the Coal Measures are altered by contact with the mass of micaceous granite of which the western slope of the mountain consists, and graphite is met with in a shaft. The following are Analyses of the graphite by Mr. Rands. No. 1 was a picked sample, and No. 2 was made up of the pieces of the shale and bands of graphite taken from over the whole section:—

	No. 1.	No. 2.
Carbon	72.7	44.25
Moisture and volatile matter	6.3	7.00
Ash	21.0	48.75
	100.0	100.00



A three feet seam of coal is said to have been discovered some years ago in Selection No. 90, opposite Aurora Plantation.

Two hundred yards above Selection No. 78, on Redbank Creek, is a seam of good bright coal, four feet two inches in thickness.

In Selection No. 39, west of Aurora, is a seam of bright coal, thirteen inches thick and nearly vertical.

ANALYSES (*Rands*).

	Water.	Volatile Hydro- carbons.	Fixed Carbon.	Ash.	Specific Gravity.	Coke.
Seam in Bull's Selection (1537) ... ..	7.0	8.6	68.4	16.0 (grey)	1.50	84.4*
Selection 1767, Munna Creek (Top Coal) ...	6.0	22.6	49.9	21.5 (grey)	1.43	71.2
"    "    "    (Bottom Coal)	5.0	29.0	48.5	17.5 (reddish grey)	1.53	66.0
Jones' Selection (1311) Seam I. ... ..	2.5	26.1	62.9	8.5 (grey)	1.32	71.4
"    "    "    II. ... ..	6.0	22.4	51.1	20.5 (reddish)	1.38	71.6
"    "    "    V. ... ..	15.0	30.0	39.5	16.5 (grey)	...	53.0
"    "    "    in waterhole	5.5	28.7	51.3	14.5 (grey)	1.38	65.8
Sorensen's Selection (1737) ... ..	12.0	34.2	32.8	21.0 (white)	...	53.8
Redbank Creek, above Selection 78 ...	10.0	28.0	47.5	14.5 (reddish grey)	1.51	62.0

\* Non-Caking.

Mr. Rands remarks that the high percentage of water and ash, as well as the high specific gravity, are due to a great extent to the specimens for analysis having been taken from the outcrop of the seams.

Mr. Gregory's "Report on the Wide Bay and Burnett Districts" contains a few references to the part of the Coal Field near Bundaberg, to the north of Burrum.

An eight inch seam is seen on the south side of the Burnett District, about eight miles above Bundaberg. Above the coal are eighty feet of brown sandstones and shales. Borings to the depth of one hundred and forty feet below the coal showed black shales and several seams of coal, but nothing workable. Several thin seams of coal are exposed by Pine Creek, which falls into the Burnett three miles above Bingera. In an Appendix to his "Report on the Coal Deposits of West Moreton, &c.," Mr. Gregory gives the following analysis of coal from Pine Creek:—

Volatile in coking	...	...	...	...	...	34.3
Fixed carbon	...	...	...	...	...	57.5
Ash	...	...	...	...	...	6.2
						98.0

Coke, 63.7; Carbon in coke, 90.3; Ash in coke, 9.7.

OUTPUT OF THE BURRUM COAL FIELD.

It is only since the opening of the railway from Maryborough that the Burrum Coal Field has been worked to any extent worth mentioning. During the last eight years, the output has amounted to 187,761 tons, valued at £160,016.

## YIELD OF BURRUM COAL FIELD.

1883	...	...	...	...	6,440 tons raised; value	£3,780
1884	...	...	...	...	6,150 "	3,550
1885	...	...	...	...	26,914 "	14,950
1886	...	...	...	...	39,048 "	23,189
1887	...	...	...	...	45,527 "	25,609
1888	...	...	...	...	56,634 "	30,096
1889	...	...	...	...	48,267 "	25,916
1890	...	...	...	...	58,781 "	3,2926
Totals	...	...	...	...	187,761 "	£160,016

The Styx Coal Field, near St. Lawrence, appears, from its fossils, to be on the same horizon as the Burrum Beds, although occurring in an isolated area. Where the road from Rockhampton to St. Lawrence crosses Deep Creek, one of the heads of the Styx, the Coal Measures unconformably overlies shales of the Gympie Beds. To the north they are capped unconformably by the Desert Sandstone (?) at Wilangi. To the east, between Wellington Creek and Bald Hills, beds of encrinital limestone occur in the Gympie Beds, and to the west are the fossiliferous beds of Yatton, belonging to the same series. I am indebted for the above particulars to Professor T. W. Edgeworth David, B.A., and the late Mr. James Smith.

At a point which is described as being eighty miles from Rockhampton, and twenty five from St. Lawrence by road, a shaft has been sunk to the depth of seventy feet. Two seams of coal were met with in this shaft, one said to be between sixty five and seventy feet from the surface and seven feet thick, and the other between three and four feet thick, but the depth is not stated. The late Mr. A. B. Lindon gave the following as an Analysis of the Coal:—

Moisture	...	...	...	...	...	...	2·2
Volatile hydrocarbons	...	...	...	...	...	...	31·3
Fixed carbon	...	...	...	...	...	...	62·6
Ash	...	...	...	...	...	...	3·9
Total	...	...	...	...	...	...	100·0

A sample of the coal was treated by Mr. F. Linthwaite, Locomotive Superintendent of the Central Railway. According to Mr. Linthwaite's Report—"A better sample of coal has not been used on this line." The Driver's Report to Mr. Linthwaite is as follows:—

"Queensland Central Railway,

"Locomotive Department,

"Rockhampton, July 6th, 1889.

"Report to Locomotive Foreman, 1st July, 1889, *re* Trial of Coal.

"SIR,—I have the honour to report that I found this coal to be very good for steam raising. It is very easy to work, and very clean, making very little ashes. In fact, I consider it equal to any Newcastle coal that we have been supplied with.

Weight of—	First Day.				Second Day.	
	tons.	cwt.	qr.	lb.	cwt.	qr. lb.
Train	126	0	0	0	...	*
Coal	† 4	1	0	0	...	
Ashes in fire-box and ash-pan	2	3	0	...	3	0 26
Ashes in smoke box	1	1	7	...	1	0 5
Miles run	...	...	...	165	...	225

\* Weight of train on second day—To Bogantungan, 36 tons; to Barcardine, 69 tons; Barcardine to Alice, 60 tons.

† This is the total quantity of coal used on both days.

"The run was 390 miles. In addition to the above there was the necessary shunting to be done at the commencing and concluding of each day's run.

"C. GILL, Engineman.

"Average consumption, 23·030 lb. of coal to the mile. Rockhampton to Barcardine, ... to Alice; in all, 390 miles."—"Say, 23½ lb. to the mile. F.L."

Another shaft was sunk in 1890, by the Broadsound Coal Mining Company, near the Waverley Creek Wharf, to the depth of ninety six feet. From the bottom of the shaft a bore was sunk, making the total depth one hundred and twenty eight feet. At ninety eight feet was a coal-seam fifteen inches thick. At one hundred and twenty feet the following section was met with:—

	Ft.	in.
Coal, very hard splint ... ..	1	3
Band soft grey clay ... ..	0	6
Coal, mixed splint and bituminous ... ..	2	0
Band clay ... ..	1	4
Coal ... ..	1	8

Professor T. W. F. David regards the coal-seam at the bottom of the bore as lying about two hundred and eighty feet above the lowest seam in the basin.

# VERTICAL SECTION OF THE BROADSOUND COAL BASIN OR STYX COAL FIELD.

	Ft.	in.
Stiff dark grey clay ... ..	20	0
Unconformity.		
Magnesites with fine-grained yellowish-grey sandstone (approximate)	100	0
Unconformity.		
Shales with lenticular bands of ironstone ... ..	0	4
Strata unknown. Section of them can be easily obtained by trenching in the salt pans, and the outcrops of any seams of coal which may exist in them could be proved in the same manner		
	1,000	0
Mudstones with reddish-brown ferruginous concretions, with thin beds of sandstone and limonite septaria ... ..	50	0
Soft carbonaceous sandstone ... ..	7	0
Argillaceous sandstone with bands of ironstone ... ..	27	0
Tough calcareous sandstone, fine-grained, lenticular ... ..	2	0
Dark mudstone ... ..	80	0
Hard grey sandstone ... ..	2	0
Dark grey sandstone ... ..	20	0
Hard grey sandstone ... ..	2	0
1. Hard sandy ironstone ... ..	0	4
Massive clayey sandstone ... ..	58	0
Mudstone ... ..	30	0
Massive sandstone ... ..	11	0
Mudstone ... ..	23	0
Thin-bedded, very red sandstone ... ..	37	0
Clayey sandstone ... ..	19	0
Sandstone, with ironstone bands ... ..	17	0
Massive soft carbonaceous sandstone with ferruginous bands ... ..	95	0
Shaly sandy ironstone, with white fireclay and a band of sandy carbonaceous ironstone full of fossil plants (about) ... ..	300	0
Whitish-grey, and rusty sandy shales with band of sandstone ... ..	41	0
Crumbling brown mudstone, grey and rusty sandy shales, and crumbling mudstone ... ..	60	0
Crumbling sandstone, with calcareous concretions ... ..	8	0
2. Soft sandy shales, crumbling in weathering ... ..	26	0
Sandy shales, with ferruginous concretions ... ..	8	0
Lenticular argillaceous limestone ... ..	16	6
Soft crumbling mudstone and sandy shales, with dark-brown marly shales, and thin bands of sandstone weathering rusty ... ..	100	0

1. Section of strata in first anticline 480 feet.

2. Section of strata seen in second anticline, 260 feet.

3. These strata can be tested most economically by trenching.

## VERTICAL SECTION OF THE BROADSOUND COAL BASIN OR STYX COAL FIELD—

*continued.*

							Pt.	in.
		Greenish-grey, clayey, carbonaceous sandstone	...	...	...	...	58	0
		Coal	...	...	...	...	0	3
		Coal	...	...	...	...	0	3
4.		Nodules of clay ironstone	...	...	...	...	1	0
		Coal and shale mixed	...	...	...	...	1	6
		Nodules of clay ironstone	...	...	...	...	0	3
		Shaly sandstone, gritty in upper 5 feet	...	...	...	...	12	6
		Hard greenish-grey calcareous sandstone, with grains of coal	...	...	...	...	12	6
		Strata unknown. No section obtainable—coal-seams probably occur in these strata (very approximate)	...	...	...	...	1,850	0
		Sandstone rather coarse, with bean-shaped concretions of limonite; there is a thinly bedded coal-seam here (?) probably the one now struck at No. 1 shaft, Newport	...	...	...	...	20	0
		Grey sandy shale with bands of clay ironstone from $\frac{1}{2}$ inch to 3 inches thick (approximate)	...	...	...	...	280	0
		Coal-seam hereabouts (?). Main seam (?).	...	...	...	...		
5.		Grey sandy shales with bands of clay ironstone $\frac{1}{2}$ inch to 3 inches thick	...	...	...	...	0	3
		Whitish-grey calcareous clay shale	...	...	...	...		
		Sandstone fairly hard, fine-grained, flaggy, carbonaceous, in upper part hard calcareous	...	...	...	...	10	0
		Clayey ironstone with abundant fossil plants	...	...	...	...	0	6
		Grey sandy calcareous clay shale (approximate)	...	...	...	...	50	0
		Band of clay ironstone with fossil plants	...	...	...	...	0	6
		Fine sandstone (very approximate)	...	...	...	...	10	0
6.		Massive glistening hard sandstone, resembling Hawkesbury Sandstone of New South Wales, contains casts of plants, and at base of bed, where it passes into a fine conglomerate, as near the Pilot Station, St. Lawrence, it shows casts of <i>Spirifer</i> s and <i>Martinia subradiata</i> , a shell in New South Wales especially characteristic of the Permo-Carboniferous Formation in which occur the valuable Greta Coal Measures. Part, therefore, of this bed, and portion of the underlying strata, probably are of Permo-Carboniferous age, and may contain the Greta Coal Seams	...	...	...	...	50	0
		Hard shales, dark grey and light grey, with thin bands of ironstone at top of series, and beds of cherty shales with <i>Archaeocalamites</i> (?)	...	...	...	...		
		Coarse pebble conglomerate (a break in the middle of the section).						
		Unconformity.						
		Limestone.						
		Limestone.						
		Dark gray argillaceous felsites.						
		Quartz felsites.						

4. J. B. Christian and Coy., Shaft, 152 feet.

5. These strata can be prospected by means of a number of shallow shafts.

6. Strata usually associated with the Greta Coal Measures.

Since the above was written Mr. W. H. Rands has completed a survey and made a report on the Styx Coal Field. The report contains a mass of valuable information regarding the coal-seams, but throws little light on the age of the measures. Mr. Rands says: "There is no evidence to show whether they (the Coal Measures) are the equivalents of the Ipswich or the Burrum Beds. All that can be said with certainty is that they are Mesozoic. They are older than the Upper Cretaceous Desert Sandstone, by which they

are overlaid unconformably, and newer than the Permo-Carboniferous rocks, in a depression of which they have been deposited, and on which they are resting unconformably. I understand from Professor Edgeworth David, who spent some time in this district examining these beds, that *Tæniopteris* was met with in Mr. Christian's shaft in Foyle Park. I also found a few indistinct leaf-markings in shales in Foyle Park, but, with these exceptions, I believe no fossils have yet been found. . . . Evidence of contemporaneous volcanic action is met with in Shaft No. 5, Waverley Creek, where fifty-seven and a half feet of tufaceous sandstone, containing white porphyritic particles, were passed through."

Mr. Rands estimates the thickness of the Coal Measure strata, in the neighbourhood of Tooloombah and Deep Creek, at about five thousand feet.

It may be remarked that the paucity of fossils in the Styx Coal Measures is a characteristic feature of the Burrum Coal Field also—whatever may be the value of such purely negative evidence. On the other hand, the presence of contemporaneous igneous rocks in the Styx Coal Measures is a point which the latter have in common with the Ipswich Coal Measures and not with those of Burrum, so far as is known.

#### LIST OF FOSSILS OF THE BURRUM BEDS, WITH THEIR SYSTEMATIC POSITIONS.

Kingdom—PLANTÆ.

Section—CRYPTOGAMIA.

Class—ACOTYLEDONES.

Order—FILICES.

Family—SPHENOPTERIDÆ.

Genus—SPHENOPTERIS, Brongniart.

*Sphenopteris flabellifolia*, Ten. Woods.

Loc. "Burnett River, half-way between Bundaberg and Five Coal Seams."

*Sphenopteris flabellifolia*, var. *erecta*, Ten. Woods.

Loc. As above; and "Burrum Coal Field."

Genus—TRICHOMANITES, Goeppert.

*Trichomanites laxum*, Ten. Woods.

Loc. Burrum. Occurs also at Rosewood, near Ipswich.

Family—PRIOPTERIDÆ.

Genus—ALETHOPTERIS, Sternberg.

*Alethopteris australis*, Morris.

Loc. "Burrum Coal Field." Occurs also at Stewart's Creek, Rockhampton, and in the Ipswich Formation.

Family—NEUROPTERIDÆ.

Genus—THINNFELDIA, Ettingshausen.

*Thinnfeldia media*, Ten. Woods.?

Loc. Burrum Coal Field, near Maryborough. Occurs also in the Ipswich Formation.

Family—TÆNIOPTERIDÆ.

Genus—TÆNIOPTERIS, Brongniart, 1828.

*Tæniopteris* (? *Angiopteridium*) *Daintreei*, McCoy.

Loc. Styx Coal Field (Burrum Beds). Occurs also in the Ipswich Beds.

Section—PHANEROGAMIA.

Class—DICOTYLEDONES.

Order—CYCADACEÆ.

Family—ZAMIÆ.

Genus—PODOZAMITES, F. Braun.

*Podozamites Kidstoni*, Eth. fl.

Loc. Burrum Coal Field, near Maryborough.

*Podozamites*, sp. ind., Pl. 18, f. 4.

Loc. Burrum Coal Field, above the Bridge Scam.

Genus—OTOZAMITES, F. Braun.

*Otozamites*, ? *sp. ind.*, Pl. 17, f. 8.

*Loc.* Burrum Coal Field, above the Bridge Seam.

Order—CONIFERÆ.

Family—TAXACEÆ.

Genus—BAIERA, F. Braun.

*Baiera bidens*, Ten. Woods.

*Loc.* Burnett River.

Kingdom—ANIMALIA.

Sub-Kingdom—MOLLUSCA.

Section—MOLLUSCA VERA.

Class—PELECYPODA.

Order—VENERACEA.

Family—CYRENIDÆ.

Genus—CORBICULA, Mühlfeldt.

*Corbicula burrumensis*, Eth. fil., Pl. 34, figs. 9 and 10.

*Loc.* Queensland Co.'s Coal Mine, Burrum.

Order—PHOLADACEA.

Family—GASTROCHÆNIDÆ.

Genus—ROCELLARIA, Blainville.

*Rocellaria terra-regina*, Eth. fil.

*Loc.* Queensland Co.'s Coal Mine, Burrum.

## SYNOPSIS.

### OCCURRING IN BURRUM FORMATION.

*Sphenopteris flabellifolia*, T.W.

" " var. *erecta*, T.W.

• *Trichomanites laxum*, T.W.

• *Thinnfeldia media*, T.W.?

• *Teniopteris Daintreei*, McCoy (Styx River).

• *Alethopteris australis*, Morr.

*Podozamites Kidstoni*, Eth. fil. (*sp. nov.*)

" *sp. ind.*, Pl. 18, fig. 4.

*Otozamites*, ? *sp. ind.*, Pl. 17, fig. 8.

*Baiera bidens*, T.W.

*Corbicula burrumensis*, Eth. fil. (*sp. nov.*)

*Rocellaria terra-regina*, Eth. fil. (*sp. nov.*)

\* Also in Ipswich Formation, including Stewart's Creek (Rockhampton) Beds.

Of the twelve species above named, four are common to the Ipswich Formation, and the remaining eight are peculiar to the Burrum Formation.

It will be seen from the preceding list that, with the exception of the genus *Sphenopteris*, the Burrum Formation has nothing in common with the Permian-Carboniferous System.

On the other hand, as four out of ten plants are specifically identical with plants occurring in the Ipswich Formation, the connection between the two formations must be a close one. When my Geological Map was published in 1886, I inclined to regard the "Burrum Beds" as Triassic and the "Ipswich Beds" as Jurassic, but, in view of the more complete evidence now available, it seems reasonable to regard them as subdivisions of a single period—the Trias-Jura. The Burrum Beds, therefore, are provisionally classed as Lower Trias-Jura.

J.

NOTE TO PAGE 7.—The heading of the paragraph occurring after the Yield of Herberton Tin Field should read "Kangaroo Hills and Running River Tin and Silver Fields." The Running Creek referred to in the next paragraph is in the Star River District.

## CHAPTER XXIV.

### THE ORGANIC REMAINS OF THE TRIAS-JURA SYSTEM, WITH DESCRIPTIONS OF THE SPECIES OCCURRING IN THE BURRUM FORMATION (LOWER TRIAS-JURA).

In this System are comprised such fossiliferous strata as lie, so far as their position can be ascertained, between those horizons representing the uppermost Fresh-water Coal Measures of the Bowen River Coal Field, and the Rolling Downs Formation.

This Series is of the utmost importance, because it contains the chief workable coal-seams in Queensland, or at least the principal seams at present worked. The organic remains are principally those of plants, with a strong Mesozoic facies, and oscillating, in all probability, between the Trias and Upper Oolite in age. They have been studied by Messrs. Carruthers and Feistmantel, and the late Rev. J. E. Tenison Woods. The last named, in his "Fossil Flora of the Coal Deposits of Australia," has endeavoured to assign many of these plants to horizons corresponding with those of their nearest allies of Europe and elsewhere, and in this way has accounted for the presence in Queensland of the Trias? Rhætic or Lower Lias, Upper Lias, and Jurassic. But our knowledge of these plant beds is too young at present for such minute subdivision, and we know far too little of the association of the species one with the other, and the similar relation of their respective matrices, to assign minute geological horizons, on the chance of a mere guess, or hasty generalisation, turning out correct.

The principal deposits yielding Mesozoic plants in Queensland are :—

#### IPSWICH COAL MEASURES at—

- Redbank, near Mount Esk, Brisbane River.
- Cressbrook and Colinton, Brisbane River.
- Bundanba Colliery, Ipswich.
- Tivoli Colliery, Ipswich.
- Walloon Colliery, Ipswich.
- Rosewood (Southern and Western Railway).
- Peak Mountain, near Fassifern, twenty miles from Ipswich.
- Talgai, near Warwick.
- Darling Downs, near Toowoomba.
- Stewart's Creek, near Stanwell.
- Wycarbah (Rosewood), near Rockhampton.

#### BURRUM COAL MEASURES—

- Burnett River Beds.

The Organic Remains from Stewart's Creek and Wycarbah are grouped with those of the Ipswich Formation.

In a Paper "On Various Deposits of Fossil Plants in Queensland,"\* the Rev. J. E. Tenison Woods gives the locality of Peak Mountain, near Fassifern, and quotes from it plants like *Rhacopteris*. Strange to say, I do not find this place mentioned in his more extended Memoir on the Coal Plants. He remarks that if the plants found there belong to *Rhacopteris* their occurrence "would indicate a much lower horizon than any beds hitherto found in Queensland." On looking over Mr. Wood's Collection,

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\* Proc. Linn. Soc. N. S. Wales, vii., Pt. 1, pp. 95-98.

now in the Macleay Museum, Sydney University, I found several well-marked and well-preserved examples of *Alethopteris australis*, Morris, sp., and *Tæniopteris*. This will naturally assign, instead of a Palæozoic age, one quite in accordance with the other beds of the Ipswich Basin. Many other deposits containing Mesozoic plants exist in Queensland, but it is not deemed necessary to mention them here.

*Glossopteris* has, on several occasions, been quoted as occurring with other Mesozoic plants in Queensland. I can only say, however, that during an experience extending over ten years, not one single instance of *Glossopteris* associated with a flora representing beds higher than the Freshwater Series of the Bowen River Coal Field has come under my notice. This sharply defined line, so far as I know, appears to hold good equally well for New South Wales. There is no reliable record of this genus being found at any horizon higher than the Upper, or Newcastle Coal Measures in the latter Province. Allied genera, such as *Sagenopteris*, do occur, but not the true *Glossopteris*, and it is probable that in cases, such as above referred to, the one has been mistaken for the other.\*

## DESCRIPTIONS OF THE SPECIES OCCURRING IN THE BURRUM FORMATION (LOWER TRIAS-JURA).

### Kingdom—PLANTÆ.

### Section—CRYPTOGAMIA.

### Class—ACOTYLEDONES.

### Order—FILICES.

### Family—SPHENOPTERIDÆ.

### Genus—SPHENOPTERIS, Brongniart, 1828.

(Prod. Hist. Vég. Foss., p. 50.)

### SPHENOPTERIS FLABELLIFOLIA, Ten. Woods.

*Sphenopteris* (*Ancimnioides*) *flabellifolia*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 94.

*Sp. Char.* Frond delicate, small bipinnate, rachis terete, somewhat thick; pinnæ oblong, cuneate, contracted at the base to a delicate petiole, lower edge entire, upper divided into linear cuneate lobes of varying width, the edges straight or rounded, some of the pinnæ much elongated, costa inconspicuous, veins fine, close, numerous, straight, radiating. (*Ten. Woods.*)

*Obs.* This species is said by its Author to possess a strong resemblance to *Archæopteris*. The type specimen reminds me of a small species of Dawson's genus *Aneimites*.

*Loc.* Burnett River, half way between Bundaberg and Five Coal Seams (*Rev. J. E. T. Woods*)—Blue shale.

### SPHENOPTERIS FLABELLIFOLIA, var. ERECTA, Ten. Woods.

*Sphenopteris* (*Ancimnioides*) *flabellifolia*, var. *erecta*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii. Pt. 1, p. 94, t. 2, f. 2.

*Obs.* Of smaller size, and regularly pinnate, the pinnæ lobed or segmented symmetrically at both sides. Although differing from the species proper, the venation

\* Since the above was written, a plant which I have satisfied myself is a true *Glossopteris* has been found by Mr. W. H. Rands, near Pentland, on the Northern Railway, in strata which my Colleague has ascertained to lie unconformably on the "Rolling Downs Formation," and which, therefore, he believes to be part of the Desert Sandstone. See Chapters on the Desert Sandstone. (*R. E. Junr.*)



and general shape of the lobes is said to be the same. As this fern occurs intimately mixed with the preceding on the same slab, it must be retained as a variety, although individual specimens here and there differ widely. It is not unlike an *Eremopteris*.

*Loc.* With the preceding, and in the Burrum Coal Field (*W. H. Rands*).

*Genus*—*TRICHOMANITES*, *Goeppert*, 1836.

(*Syst. Fil. Foss.*, p. 174.)\*

*TRICHOMANITES LAXUM*, *Ten. Woods?* Pl. 18, fig. 9.

*Trichomanides laxum*, *Ten. Woods*, *Proc. R. Soc. N. S. Wales*, 1883, viii., Pt. 1, p. 95, t. 10, f. 2.

*Sp. Char.* Rhizome creeping, long, slender, sending up at distant irregular intervals delicate membranaceous pinnate fronds; pinnæ emerging at an acute angle, linear, or cuneate, bifurcating with one simple free vein to each lobe. (*Ten. Woods*.)

*Obs.* *T. laxum* is said to be distinguished from *T. elongata*, *Carruthers*, sp., by being much smaller, and consisting "of short pinnate fronds proceeding at irregular intervals from the slender creeping rhizome."

*Mr. R. Kidston* believed he could recognise this amongst *Mr. Rands'* Collection of plants from the Burrum Coal Field. He remarks as follows:—"This fossil shows a fragment of a very graceful species. The pinnules are divided into a number of simple, or bifid-linear, acute segments. The characters of *T. laxum* are simply unintelligible. If *Mr. Tenison Woods* supposed his figure to represent a rhizome, as I am led to think from his description, there appears to be a mistake in the interpretation of the fossil, which more probably shows part of a compound frond."

*Loc.* Burrum (*W. H. Rands*). Occurs also at Rosewood, near Ipswich.

#### Family—NEUROPTERIDÆ.

*Genus*—*THINNFELDIA*, *Ettingshausen*, 1852.

(*Abhandl. K. K. Geol. Reichsanstalt*, i., Abth. 3, No. 3, p. 1.)

*THINNFELDIA MEDIA*, *Ten. Woods*, Pl. 17, fig. 2, Pl. 18, fig. 10.

(Compare Pl. 17, f. 7.)

*Thinnfeldia media*, *Ten. Woods*, *Proc. Linn. Soc. N. S. Wales*, 1883, viii., Pt. 1, p. 102, t. 6, f. 1.

(Compare *Thinnfeldia indica*, *Feistmantel*, *Pal. Indica* (*Gondwana Flora*), 1877, i., Pt. 2, t. 39, f. 1, 1d, t. 46, f. 1-2 a.)

*Sp. Char.* Frond bipinnate? pinnæ quite close, nearly opposite, broadly lanceolate, broadly obtuse; the lower ones shorter, attached by the whole of the base where it is only very slightly constricted; veins only faintly visible, but there are traces of a costa in nearly all the pinnules, which is evanescent; rachis very thick. (*Ten. Woods*.)

*Obs.* These characters were assigned by the *Rev. Mr. Woods* to a plant from the *Hawkesbury Sandstone* of *Dubbo*, which he compared to *Thinnfeldia indica*, *Feistmantel*. "It bears some resemblance to *T. indica*, *Feistmantel*, and more to *T. decurrens*, *Schenk*."

With specimens of the *Dubbo* plant I am not acquainted, but in referring the *Queensland* ferns (Pl. 17, fig. 2, and Pl. 18, fig. 10) to *T. media* I am simply relying on *Woods'* description, and his reference to *T. indica*, to which the figures undoubtedly have a strong resemblance. It must, however, be acknowledged that such a point as "veins only faintly visible" does not wholly agree with our specimens; but on the other hand, "attached by the whole base," "traces of a costa," and "rachis very

\* Die fossilen Farrnkriuter (*Nova Acta. Acad. Leopold. Carol. Curiosorum*, Bd. xvii., Suppl.)

thick," are features plainly visible in the Queensland specimens. In the example from the Burrum (Pl. 17, fig. 2) the venation is indistinct, and we have only the form of the leaflet to guide us, and this is unmistakably that of *T. indica*. In the subject of Pl. 18, fig. 10, the venation is very strongly marked, the peculiar right-angled deflection and bifurcation, so characteristic of *Thinnfeldia*, being present; and, finally, there are traces of a by no means weak costa. Here again we observe a marked resemblance in the outline of the pinnules to those of *T. indica*, particularly Pl. 39, fig. 1, of the reference above cited.

I may, perhaps, be again allowed to refer to Pl. 17, fig. 7, representing a specimen which seems to oscillate between the type species and this form, or perhaps one of the varieties of the former. It is very like the type of Woods' *T. media* in the Macleay Museum, Sydney University.

Mr. G. Sweet has obtained a bifurcating frond, seven inches long, with a large number of pinnules *in situ*, which are either long and curved, lanceolate, diminishing to a fine distal point, or short, obtuse, and bluntly rounded, both on opposite and the same sides of the rachis. There is a decided false midrib to the pinnules, which disappears before reaching their apices. The rachis, below the bifurcation, is nearly three and a half inches long, and striate, with pinnules on each side. The form of the pinnules is precisely that of Feistmantel's Pl. 46, f. 1, and the habit that of his Pl. 39, f. 1. The specimen greatly confirms me in the belief that *Thinnfeldia media* and *T. indica* are very near, if not identical.

*Loc.* Burrum Coal Field, near Maryborough, Pl. 17, fig. 2 (*W. H. Rands*). Occurs also in the Ipswich Beds.

#### Family—PECOPTERIDÆ.

*Genus*—*ALETHOPTERIS*, Sternberg, 1826.

(*Flora der Vorwelt*, Heft 4, p. xxi.)

*ALETHOPTERIS AUSTRALIS*, Morris, Pl. 16, fig. 1.

*Pecopteris australis*, Morris in Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 248, t. 7, f. 1 and 2.

*Alethopteris australis*, Schimper, Traite Pal. Vég. 1869, i., p. 569.

*Pecopteris australis*, McCoy, Geol. Survey Vict., Decade ii., 1875, p. 16, t. 14, f. 3.

*Alethopteris australis*, Feistmantel, Pal. Indica (Gondwana Flora), 1876, ii., No. 1, p. 24.

" (*Pecopteris*) *australis*, Feistmantel, Palaeontographica, 1879, Supl., Bd. iii., lief 3, heft 2, p. 109, t. 14, f. 1 and 1a; heft 3, p. 169, t. 12, f. 5, 5a.

" *australis* (*Asplenium Whitbyense*, Heer), Feistmantel, Pal. Indica (Gondwana Flora), 1881, iii., No. 3, p. 79.

" " Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 111.

*Obs.* This fern has been so adequately described by Morris, Feistmantel, McCoy, and Woods, that it is not necessary to repeat the description here.

Several very fine examples have been collected in the Ipswich Basin; one of these, from Bundamba, is a portion of a frond, eight inches long, and shows a spread of the pinnæ equal to seven inches. In the former space there are portions of four pinnæ, three attached to the rachis. This will afford some idea of the size to which it attained, two of them being respectively four and five inches long. The frond, as described by the late Rev. J. E. Tenison Woods, is bipinnate, and the pinnæ alternate and oblique. In the Bundamba specimens the secondary veins of the pinnules undoubtedly fork twice, as in Morris's original examples\* from the Jerusalem Basin, Tasmania. The margins of the pinnules are also serrate; but, on the other hand, specimens from Gray's Seam, Ipswich, present these entire, and the veinlets only bifurcate once. The occurrence of both varieties in this Coal Basin is very interesting. The rachis is highly corrugated.

\* Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 7, f. 2a.

In his earlier writings Dr. Feistmantel followed Schimper in placing this fern very near to *Alethopteris whitbyense*,\* but latterly the same Author has united it to the British fern, following Heer, referring both to the genus *Asplenium*.† On the other hand, McCoy cites *A. scarburgensis*, Bean, also from Yorkshire Oolites, as its nearest ally. In my opinion the fern figured from New Zealand, by Unger‡ is our above species. The growth is exact, and the once and twice bifurcation is present.

Mr. R. M. Johnston has described § a fern under the name of *Alethopteris serratifolia*, separating it from *A. australis* on account of the serrated edges, of undulating margin of the pinnules. This is unfortunate, because Morris, in his original description, described || these as "either sinuous or entire, according to the position of the frond." It will be necessary, therefore, to regard his specific name as a synonym of the older one. The Survey Collection contains examples of *A. australis* with serrated-edged pinnules from Ebbw Vale Colliery and other localities in the Ipswich Basin.

*Loc.* Burrum Coal Field (*W. H. Rands*). Occurs also at Ipswich and Stewart's Creek, Rockhampton (Ipswich Beds).

#### Family—TENIOPTERIDÆ.

*Genus*—TENIOPTERIS, Brongniart, 1828.¶

(Prod. Hist. Vég. Foss., p. 61.)

TENIOPTERIS (? ANGIOPTERIDIUM) DAINTREEI, McCoy.

*Obs.* For description of the species see Ipswich Beds.

*Loc.* Styx Coal Field (? Burrum Beds). Occurs also in the Ipswich Beds.

### Section—PHANEROGAMIA.

#### Class—DICOTYLEDONES.

#### Order—CYCADACEÆ.

#### Family—ZAMIEÆ.

*Genus*—PODOZAMITES, F. Braun.

(Münster's Beitr. zur Petrefactenkunde, vi., p. 36.)\*

PODOZAMITES KIDSTONI, *sp. nov.*, Pl. 18, fig. 6.

*Sp. Char.* Pinnæ elongate, narrow; pinnules of variable size and length, distant from one another, alternate, and disposed at an acute angle to the rachis; they are either short, somewhat oblong club-shaped, broad, and very blunt at their apices, or narrower and rather transversely elongated, abruptly attenuated or constricted at the base to an articulation with the rachis. Veins numerous, close, apparently simple, and more or less following the outline of the pinnules. Rachis striated and decreasing in size slowly.

*Obs.* This rather elegant plant shows a stem four and a half inches long, and about three millimetres wide at its lower extremity. On the right hand side are shown the more or less perfect remains of seven pinnules, and on the other better preserved

\* Pal. Indica (Gondwana Flora), 1876, ii., Pt. 1, p. 24.

† *Ibid.*, 1881, iii., No. 3, p. 79.

‡ Reise Österr. Fregatte Novara, 1857-59, Geol. Theil., Bd. i, 2 abth., 1865, p. 5, t. 2, f. 1 and 2.

§ Geol. Tasmania, t. 23, f. 1.

|| Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 248.

¶ Restricted—Schimper, Traité Pal. Vég., 1869, i., p. 600.

\*\* Fide Zigno, Flora Foss. Formationis Ool., ii., p. 118.

portions of five leaflets. They vary much in form and size, most of those on the right side being oblong, and with obtuse apices, whilst those on the other are much more elongate in proportion to their breadth. The pinnules seem to have been coriaceous, and the veins are numerous, fine, and parallel. The average length of the shorter leaflets is under an inch, the others reaching as much as one and a quarter inches, and imperfect.

The only fossil plant, with which I am acquainted, bearing any resemblance to this is the *Zamites Meneghini*, Zigno,\* from the Italian Oolite rocks.

*Loc.* Burrum Coal Field, near Maryborough (*W. H. Rands*).

#### PODOZAMITES, *sp. ind.*

*Obs.* Several fragments, probably referable to this genus, are in my Colleague's Collection, but as the naming of mere portions of leaves, unless exceedingly well marked, leads to no good end, I shall content myself by calling attention to the figures, hoping that more complete specimens may eventually be discovered.

Pl. 18, f. 4. Three nearly equidistant pinnules are here represented, bearing five sub-parallel veins, and terminating in a sub-acute apex. The general appearance of these leaves, and the bi-convex edges, giving rise to a rather transversely elongated ellipsoidal figure, seem to indicate the above genus. The form of the leaflet appears to be quite distinct from that of *P. lanceolatus*, L. and H.

*Loc.* Burrum, above the Bridge Seam (*Hon. W. Walsh*).

#### Genus—OTOZAMITES, *F. Braun*.

(Münster's Beitr. zur Petrefactenkunde, vi., p. 36.)

OTOZAMITES, ? *sp. ind.*, Pl. 17, fig. 8.

*Obs.* This fragment would appear to indicate a species of *Otozamites*, differing from *O. Mandeslohi*, in its much larger, fuller, and more pyriform pinnules. A larger pinnule lying near the figured example has an excavate base, which heightens the resemblance to this genus. The veins were probably distinct and well marked, and under twenty in number. It may be compared to *Otozamites Beanii*, Lindley and Hutton,† from the Yorkshire Oolites, or *O. Canossæ*, Zigno,‡ from beds of similar age in Italy.

*Loc.* Burrum, above Bridge Seam (*Hon. W. Walsh*).

### Order—CONIFERÆ.

*Obs.* *Vide* Observations on our knowledge of the Australian fossil Coniferæ under the head "Ipswich Formation."

#### Family—TAXACEÆ.

#### Genus—BAIERA, *F. Braun*, 1844.

(Münster's Beitr. zur Petrefactenkunde, vi., p. 21.)§

#### BAIERA BIDENS, *Ten. Woods*.

*Jeanpaulia bidens*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 132, t. 4, f. 3.

*Sp. Char.* Frond broadly flabellate, segments somewhat short, often becoming broader towards the apex, and ending in a short wide bifurcation, or in a curved falcate, acute, or acuminate point; veins not conspicuous, six to ten, parallel, not branching (*Ten. Woods*).

\* Flora Foss. Formationis Ool., ii., p. 33, t. 31, f. 4a.

† Cyclopteris, Lindley and Hutton, Foss. Flora i, t. 44. *Otozamites*, Phillips, Ill. Geol. York., 3rd edit., 1875, Pt. 1, p. 220, lign. 45.

‡ Flora Foss. Formationis Ool., ii., p. 95, t. 37, f. 3.

§ Beiträge zur Urgeschichte der Pflanzen, Abth. 1, in Münster's Beiträge, Heft vi., p. 21, *vide* Saporta (Pal. Franç. Plantes jurassiques, 1873, i., p. 460)—Bronn (Index Pal., i., p. 145) gives Braun's reference as "Flora," 1841, p. 33.

*Obs.* The Rev. Author of this species placed it in the Ophioglossaceæ, under the name of *Jeanpaulia*, following Schimper; but I prefer to adopt the more recent views of Dr. A. Schenk.

Mr. Woods' remarks that his species differs from the European Rbætic *B. Münsteriana*, in the brevity, widening, and bifurcation of the segments.

*Loc.* Coal Seam of the Burnett River, Burnett District, Wide Bay (*Rev. J. E. T. Woods*)—Macleay Museum, University of Sydney.

## Kingdom—ANIMALIA.

### Sub-Kingdom—MOLLUSCA.

### Section—MOLLUSCA VERA.

#### Class—PELECYPODA.

#### Order—VENERACEA.

#### Family—CYRENIDÆ.

#### Genus—CORBICULA, Mühlfeldt, 1811.

(Berliner Mag., v., p. 56.)

*CORBICULA BURRUMENSIS*, *sp. nov.*, Pl. 34, figs. 9 and 10.

*Sp. Char.* Shell ovate, sub-trigonal, length and height nearly equal, but the former rather the greater, tumid, thick and strong. Anterior and posterior margins rounded, the former the more broadly so of the two. Hinge-line, or cardinal margin much arched, especially on the posterior side, but the anterior more abruptly so. Ventral margin regularly and evenly rounded. Posterior end, when the valves are in apposition, wide and broad, giving rise to a rounded posterior slope on each valve. Concentric lines of growth strong and well marked, the surface being in addition much wrinkled.

*Obs.* I believe this is the first recognition of this genus in Australian Secondary beds. The species presents a close resemblance to *C. cytheriformis*, Meek, from the Bad Lands of the Judith River, Upper Missouri, so much so that the above diagnosis has been worded so as to express the difference between them. The Australian species is, however, apparently wider in proportion to its height, and the beaks more anteriorly recurved. As well as this, the shell probably possessed a more expressed posterior slope in each valve.

*C. burrumensis* attained a fairly large size. The discovery of Mollusca in the Burrum Coal Series is of importance, for only plant remains have hitherto been recorded.

*Loc.* Queensland Coal Co's. Mine, Burrum (*W. H. Rands*).

## Order—PHOLADACEA.

### Family—GASTROCHÆNIDÆ.

#### Genus—ROCELLARIA (*Fleuriau de Bellevue*), *Blainville*, 1828.

*Gastrochæna*, Lamarck (*Spengler partim*), Hist. Anim. Sans Vertèb., 1818, v., p. 446.

*Rocellaria* (F. de B.) *Blainville*, Dict. Sc. Nat., 1828, lvii., p. 244.

*ROCELLARIA TERRA-REGINÆ*, *sp. nov.*, Pl. 28, figs. 13 and 14.

*Sp. Char.* Valves unknown; tube elongately pyriform, tapering rapidly; anterior end rounded, inflated, and somewhat flattened at the minor termination of the tube,

becoming gradually narrower towards the posterior end, which appears to be oval; surface apparently obliquely striated at the anterior end, but concentrically grooved on the posterior.

*Obs.* The *Gastrochænidæ* would appear to be a more fitting resting place for this peculiar fossil than the *Teridinæ*, to which I at first supposed it to belong. The fossils appear to be crypt-like tubes quite closed at the anterior end, without any trace of distinct valves, such as would be apparent if it related to *Teredo* or its allies.

The specimens closely resemble a *Rocellaria* figured by Stoliczka\* from the Arrialoor Group, but without name, but they possess a proportionately larger tube and taper much more rapidly.

*Loc.* Queensland Coal Co.'s Mine, Burrum (*W. H. Rands*).

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\* *Pal. Indica* (Cre Pelecyp.), 1870, i., Pt. 1-4, t. 1, f. 8.

## CHAPTER XXV.

### THE TRIAS-JURA SYSTEM—*continued.*

#### THE IPSWICH FORMATION (UPPER TRIAS-JURA), IN THE TYPE DISTRICT.

An area of about twelve thousand square miles in the south-eastern corner of Queensland is occupied by the Ipswich Coal Field. Its strata consist for the most part of fine conglomerates, grits, white, grey, and brown sandstones and shales, with a number of coal-seams and beds of fireclay.

At or near the base of the formation, as seen in the neighbourhood of Brisbane, is a rock consisting of a felspathic matrix, with blebs of quartz and some crystals of orthoclase felspar, and containing pebbles of micaceous schist and quartz, which, towards its base, attain the size of boulders. It is generally white or yellowish-white in colour, although in places it has green, purple, or brown tints. Near its base it contains pieces of silicified and carbonised wood. This rock, which is easily worked, yet tough and durable, has been employed ever since the founding of the City as a building stone, although in modern buildings it is now, to a great extent, superseded by the sandstones of Murphy's Creek, &c., which also belong to the Ipswich Formation. It is obviously a clastic rock, although felspar crystals and quartz blebs have been developed in it subsequent to its deposition. It has a rude sort of stratification, and its true nature can best be observed on weathered surfaces. It was formerly classed as a porphyry, and regarded as being intrusive through the schists, &c., which crop out in adjoining portions of the City; but there can be little doubt that it is in reality a volcanic ash.

In the road cutting in Ann Street the ash or ashy sandstone dips at 18°, and is separated by thirty one inches of light and dark-coloured shales from the older micaceous schists on which the shales lie unconformably. Near the Children's Hospital, a conglomerate intervenes between the ash and the schists.\*

In the immediate neighbourhood of Brisbane the Ipswich Formation has not yet furnished any coal-seams of great importance. In a well at Kedron Lodge the strata observed between the depths of twenty five and forty feet were alternate layers of coal and fireclay, the former never over one foot in thickness. Small coal-seams have been met with in shafts at Ballinger's, about three miles north of Kedron Brook.

In a bore in search of artesian water at the Racecourse, or "Eagle Farm," in 1889, "down to a depth of six hundred and fifty feet, the strata passed through were blue and grey sandstones, and shales in alternate layers. From six hundred and fifty feet to six hundred and seventy feet a bed of carbonaceous shale, with layers of sandstone, and three seams of coal, was passed through. From six hundred and seventy feet shale and sandstone, with layers of coarse gravel, were pierced, till at a depth of seven hundred and ninety feet, a seam of good coal was met with, which, so far as could be judged by the nature of the drilling and the sludge brought up in the pumps, has a thickness of five or six feet. Below this seam a carbonaceous shale, sandstone, and thinner seams of coal, from six inches to three feet in thickness, have been passed through, down to the depth of eight hundred and seventy five feet."†

\* Report to accompany Geological Map of the City of Brisbane and its Environs. By W. H. Randa. Brisbane: by Authority: 1887.

† Report of Mr. William McKinnon, Overseer to the Hydraulic Engineer, 18th June, 1889.

the head of 'Darkie's Flat.' These rocks, however, do not extend uninterruptedly from the range to both waters mentioned. To the north-west of Mount Gammie, sandstones, conglomerates, and occasionally shales, belonging to the Ipswich Coal Measures, stretch from near the Miner's Creek Bridge to within less than a mile of the old Talgai Township, and, continuing along the foot of the range, follow the south-west branch of Mocatta Creek to within a mile of the Condamine. On the south-east side of the range also, a patch of the same kind of rock, but of small extent, occurs close to the west boundary of the township of Pratten."

The junction of the auriferous rocks with the [Ipswich] Coal Measures is spoken of by Aplin\* as occurring "on the west side of the divide between Thane's and Canal Creeks."

*Report on the Auriferous Country of the Upper Condamine, &c.*—In sinking a shaft about one mile from the old Talgai Township, a coal-seam was said to have been struck. "On the authority of one of the men who were engaged in putting down the shaft, the thickness of the coal was from eight to ten feet. The reason assigned for there being no evidence of so thick a seam cut through and brought to the surface was that the coal was consumed by his party while sinking the remaining one hundred and fifty feet, the coal having been struck at seventy feet. Judging of its quality from the few fragments lying near the shaft, there would appear to have been a good deal of black shaly material associated with a clean, bright-looking coal."

In 1887 Mr. Rands described† as follows, the Ipswich Coal Measures of the neighbourhood of Beenleigh:—

"The boundary of the Coal Measures runs in a south-south-east direction from Kingston Railway Station, the beds extending away in a westerly direction towards Goodna and Ipswich.

"The measures consist of a series of sandstones, shales, clays, and seams of coal; the beds are lying very flat and gently undulate, the direction of the dip varying in different places.

"The following is a description of the places where the indications of coal were pointed out to me, starting from north of Beenleigh:—

"Shailer's Selection (No. 261).—An outcrop of coal and black carbonaceous shale occurs in the bed of a gully running into Slack's Creek. The section is partly hidden by water; it is from twelve to thirteen feet thick, and consists of alternate layers of coal and a very carbonaceous shale, with one small band of sandstone about four inches thick.

"The bottom portion is said to contain the best coal. From this part I broke off a few large lumps of hard bright coal. The thickest coal without bands of shale is from fifteen to eighteen inches thick. The bed is dipping about 6° to N. 35° E. in the direction of the top of the ridge, where the boundary line of the schists occurs, about half-a-mile distant. . . . I brought away a piece of this coal for analysis. It gave—

	Per cent.	
Moisture . . . . .	1.00	
Volatile hydrocarbons . . . . .	24.14	
Fixed carbon . . . . .	50.31	} Coke 74.86 per cent.
Ash . . . . .	24.35	
	100.00	

The coke was brittle and compact, the ash light-grey in colour. The ash is naturally very high in a sample of coal taken from the outcrop of a seam.

\* *Loc. cit.*

† Report by W. H. Rands on the Geology, &c., of the Country in the Neighbourhood of Beenleigh, and of the Logan and Albert Rivers. Brisbane: by Authority: 1887.



"In Dennis' Selection (121), a thin seam of coal is visible in a gully. The section here consists of—

	Ft.	in.
Black carbonaceous shale...	7	0
Argillaceous and carbonaceous sandstone ...	1	0
Brown sandy shale ...	5	0
Coal... ..	0	6
Fissile grey shale...	thickness unknown	

Beneath, again, is a thick bed of yellow sandstone. The dip of the strata here is 5° N. 35° E.

"In Selection 393, close to the Railway, two men are sinking a shaft, which is now sixty feet deep, in search of coal. The dip here is one in ten or twelve to the east. They pass through—

	Ft.	in.
Sandstone and shale, with bands of ironstone ... ..	35	0
Black shale, with thin seams of coal (1 to 2 in. thick) ... ..	12	0
Black carbonaceous shales containing <i>Pecopteris</i> ... ..	9	0
Hard grey sandstone (not yet through) ... ..	3	0

The above thicknesses are only approximate.

"Shales and sandstones belonging to the Coal Measures dip north-east in a cutting on the Railway line north of Kingston Railway Station. Mr. Charles Kingston has done a little prospecting for coal on Scrubby Creek (selection 266). In a hole seventeen feet deep, two six-inch seams were cut; and a little further west, in a cutting in the bank (now nearly full of water), a shale full of streaks of coal can be seen. Mr. Kingston informed me that in the bottom of the cutting a sixteen-inch seam of coal was met with. Several outcrops of shale and coal are to be seen when the creek is dry. Dip, 7° W. 10° S.

"Three and a half miles south of Scrubby Creek, in Selection 56, a seam of coal, fifteen inches thick, is said to have been met with in a drive put into the steep bank of the Logan River. A small seam, a few inches thick, outcrops in a gully close by. Dip, 7° W.N.W.

"About a mile higher up, and on the opposite or eastern side of the river, a good section is visible in the steep bank. The strata dip very slightly east-north-east and consist of—

	Ft.	in.
Thin-bedded sandstone and shale with thin beds of coal and fireclay, about ... ..	15	0
Black band and shale ... ..	6	0
Black band with bed of impure coal 12 inches thick ... ..	5	6
White clay ... ..	0	8
Black band and shales.		

Three-quarters of a mile south-west from the river here, a shaft was sunk, forty feet in depth, on Selection 261, by a man named Smith. Carbonaceous shales with streaks of coal were passed through. At forty feet, a seam of coal was struck. Mr. Smith and another man working with him were suffocated on descending the shaft by foul air which had collected at the bottom. Since this fatality, which happened some months ago, no further sinking has been done to test the thickness of the seam. The shaft is close to the boundary of the Coal Measures.

"Mr. Downman has done more than anyone in the district towards proving the presence of payable seams of coal by putting down a borehole to the depth of two hundred and ninety one feet near the centre of his Selection (No. 68). Mr. Falconer

superintended the putting down of the borehole; the borer used was a steel cutter. The size of the cores brought up was about three inches in diameter near the surface, and two inches lower down :—

						Thickness.			Depth.	
						Ft. in.			Ft. in.	
Surface ...	...	...	...	...	...	72	8	...	72	8
Shale ...	...	...	...	...	...	1	6	...	74	2
Shale ...	...	...	...	...	...	2	6	...	76	8
White sandstone	...	...	...	...	...	4	6	...	81	2
Sandstone and shale	...	...	...	...	...	5	6	...	86	8
Sandstone	...	...	...	...	...	2	0	...	88	8
Black shale	...	...	...	...	...	4	0	...	92	8
Light shale	...	...	...	...	...	1	6	...	94	2
Shale ...	...	...	...	...	...	2	3	...	96	5
Black shale	...	...	...	...	...	5	9	...	102	2
Shale ...	...	...	...	...	...	2	0	...	104	2
Sandstone and quartz	...	...	...	...	...	1	0	...	105	2
Grey sandstone...	...	...	...	...	...	12	0	...	117	2
Coal ...	...	...	...	...	...	4	0	...	160	8
Black shale with coal	...	...	...	...	...	12	0	...	129	4
Black shale	...	...	...	...	...	0	10	...	130	2
Calcareous sandstone	...	...	...	...	...	2	6	...	132	8
Black shale	...	...	...	...	...	5	0	...	137	8
Shale and sandstone	...	...	...	...	...	19	0	...	156	8
Coal ...	...	...	...	...	...	4	0	...	160	8
Shale ...	...	...	...	...	...	1	8	...	162	4
Hard siliceous band	...	...	...	...	...	1	0	...	163	4
Shale ...	...	...	...	...	...	6	0	...	169	4
Coal ...	...	...	...	...	...	0	3	...	169	7
Black sandstone	...	...	...	...	...	11	0	...	180	7
Shale ...	...	...	...	...	...	6	4	...	186	11
Coal ...	...	...	...	...	...	4	1	...	191	0
Sandstone	...	...	...	...	...	9	0	...	200	0
Blue fossiliferous shale	...	...	...	...	...	11	0	...	211	0
Fireclay ...	...	...	...	...	...	0	2	...	211	2
Shale ...	...	...	...	...	...	7	4	...	218	6
Fireclay ...	...	...	...	...	...	0	11	...	219	5
Grey sandstone	...	...	...	...	...	21	3	...	240	8
Fireclay ...	...	...	...	...	...	0	3	...	240	11
Hard grey sandstone and shale	...	...	...	...	...	19	5	...	260	4
Coal ...	...	...	...	...	...	0	4	...	260	8
Shale ...	...	...	...	...	...	2	2	...	262	10
Coal with bands of shale	...	...	...	...	...	1	6	...	264	4
Good hard coal	...	...	...	...	...	5	3	...	269	7
Shale ...	...	...	...	...	...	0	3	...	269	10
Fireclay ...	...	...	...	...	...	0	2	...	270	0
Shale with bands of coal	...	...	...	...	...	5	6	...	275	6
Fireclay ...	...	...	...	...	...	1	4	...	276	10
Coal ...	...	...	...	...	...	2	0	...	278	10
Black band	...	...	...	...	...	0	8	...	279	6
Coal ...	...	...	...	...	...	5	3	...	284	9
Hard sandstone	...	...	...	...	...	0	2	...	284	11
Coal ...	...	...	...	...	...	0	4	...	285	3
Hard sandstone	...	...	...	...	...	0	8	...	285	11
Hard sandstone with bands of ironstone	...	...	...	...	...	5	1	...	291	0

"According to this return, therefore, there were four seams of coal of sufficient thickness to pay to work passed through in the boring—viz., a four feet seam at one hundred and sixty feet in depth, a four feet one inch seam at one hundred and ninety one feet, a five feet three inch seam at two hundred and sixty nine feet, and a seven feet eleven inch seam (including eight inches of band) at two hundred and seventy eight feet in depth. Unfortunately none of the cores of coal were kept, so that I was unable to see the quality of the coal.

"A sample of the bottom seam (the seven feet eleven inch seam) was sent to Mr. A. C. Gregory, who reports as follows:—

	Per cent.
'Fixed carbon... ..	58·5
Volatile in coking ... ..	22·5
Ash ... ..	19·0

A fair coal for steam purposes and household use, also for smith's work. The high percentage of ash is probably due to *débris* from the boring being mixed with it.' This coal would answer admirably where an avoidance of smoke was an object, as the percentage of the volatile hydrocarbons is small. The site of the borehole is only about ten or fifteen chains from the Logan River. Mr. Downman tells me that steamers of two hundred tons burden have come up the river to this point for the purpose of carrying away timber, so that there would be no difficulty in the way of the conveyance of the coal to the Brisbane market.

"At present the nearest available Railway Station is Kingston, about seven miles distant. The Logan Village line passes about half-a-mile from the spot, but it is on the opposite side of the Logan River.

"I was informed by Mr. Downman that coal can be seen outcropping in Chambers Creek, in the same Selection, when the water is low.

"Mr. Watt accompanied me to his Selection (No. 11), three miles south-east of the Logan Village, where the following section of rocks is exposed in a gully:—

	Ft.	in.
Fine-grained brown sandstone ... ..	3	0
Black shale, with bands of <i>coal</i> and clay ... ..	8	0
Black and brown shales, with <i>coal</i> and thin bands of sandstone ... ..	12	0

The dip is 8° W.S.W. A shaft forty seven feet in depth has been sunk in the gully close to the base of the black and brown shales. A seam of cannel coal, about a foot thick, was cut near the top of the shaft, and, lower down, a seam of coal about fifteen inches in thickness. A proximate analysis of a piece of this coal is appended:—

	Per cent.
Moisture ... ..	1·32
Volatile hydrocarbons ... ..	19·71
Fixed carbon ... ..	47·37
Ash ... ..	31·61
	<hr/> 100·00

The coke was hard and somewhat compact; the ash was of a slightly reddish-grey colour. The coal was hard and bright, with thin scales of silica on its faces; this would account for the high percentage of ash. These scales of silica would probably not occur at any depth from the surface. In testing this ground for coal, it would be better to sink or bore lower down the gully, on the flat to the dip of the beds.

"On the top of the ridge at the head of this gully there is a bed of freestone at least one hundred and three feet thick. Mr. Watt has had some specimens of this stone faced; it would make an excellent building stone, being hard and durable. This ridge extends right across the Albert River.

"Following up Sandy Creek, from its junction with the Albert River to Mount Tambourine, brown and yellow sandstone, with here and there shales with streaks of coal, occur. Mount Tambourine itself consists of leucitic basalt, overlying the Coal Measures sandstone. At the head of this creek a fine section of this basalt is seen, where the water, falling from a height of about one hundred feet, has made a cutting through it. I was informed that the outcrop of a thick seam of coal is visible in Flagstone Creek, twenty miles south of Beenleigh."

In his "Report on the Albert and Logan district," \* Mr. Rands added the following notes :—

"The boundary between the Ipswich beds and the schists runs in a north-north-westerly direction from the heads of Nerang Creek to Mount Tambourine; it passes under the basalt of that mountain, and then continues in the same direction, running between Sandy and Cedar Creeks, and crossing the Albert River about a mile above its junction with Cedar Creek. It continues on in the same direction for about six miles, and then bends to the north, crossing the Railway Line and the Logan River near the village of Waterford. From thence it runs in a north-westerly direction to Kingston Railway Station, and then in a north-easterly direction to Mount Cotton, from which place it runs in a south-easterly direction to Alberton and Ageston.

"The beds consist of a series of sandstones, shales, and clays, with seams of coal. The beds dip generally at a low angle; the direction and amount of the dip in various places is shown on the map.

"At Ageston the country is covered with alluvial deposits; coal was met with below the alluvium, in a borehole on Mr. W. H. Couldery's property, in Selection No. 2.

"In my Report on the Beenleigh District, 1887, I described these beds and the outcrops of coal that occur from Tambourine Mountain, as far north as Shailer's Selection, No. 261.

"Hearing that Mr. Watt had opened up another seam of coal, I revisited his Selection No. 11. A drive sixteen feet long has been put in on a seam of coal which lies immediately beneath the freestone mentioned in my last Report. The section seen here is :—

	Ft.	in.
Freestone ... ..	50	0
Black carbonaceous shale with streaks of coal ... ..	0	4
Light yellowish clay ... ..	0	6
Dark brown laminated shale with coal and sandstone ... ..	1	0
Coal with a thin streak of clay ... ..	0	5½
Clay-band ... ..	0	1
Coal ... ..	0	4½
Clay-band ... ..	0	1
Coal... ..	0	2½
Clay-band ... ..	0	3
Coal... ..	1	0
Dark hard band ... ..	0	2
Coal ... ..	0	8
Thin laminated sandstone ... ..	0	6
Shale (coaly).		

The seam is, therefore, three feet three and a half inches thick, including seven inches of bands. Unless these bands which are distributed throughout the seam thin out, the coal will be of no commercial value. The dip of the strata here is south-west

\* Brisbane: by Authority: 1889.

at 8°. The coal is situated at the head of a gully about a hundred yards north-west of the shaft mentioned in my previous Report. The following is a proximate analysis of this coal:—

	Per cent.
Moisture ... ..	2.2
Volatile hydrocarbons ... ..	22.8
Fixed carbon ... ..	51.0
Ash ... ..	24.0
	<hr/>
	100.0

The coal cokes well on coking. The ash is light-grey in colour. The coke was much swollen up, soft, and black-coloured. The coal is laminated and friable.

"The analysis of the coal from the shaft was:—

	Per cent.
Moisture ... ..	1.32
Volatile hydrocarbons ... ..	19.70
Fixed carbon ... ..	47.37
Ash ... ..	31.61
	<hr/>
	100.00

The coke was hard and compact, and the ash of a slightly reddish-grey colour. The high percentage of ash is probably due to the samples, in both cases, being taken from close to the surface.

"The freestone overlying the coal is of a good white colour, medium in grain. It lies in beds averaging about four feet in thickness. Some of the layers are too laminated to make a good building stone, but others are massive and hard, and would make a good facing stone, though it is perhaps too coarse for fine mouldings. Stone from this ridge, which runs across to the Logan, was used for building a chimney in the Logan Village about twenty-three years ago. The stone has withstood the weathering action of the atmosphere well.

"A borehole was put down on the Timber Reserve, about two miles north of the Logan Village, to a depth of three hundred and fifty feet. After passing through the Ipswich beds, the schists were struck in the bottom of the bore. No thick coal was met with.

"In the cuttings on the Railway, between the Logan Village and Jimboomba, nothing but sandstones and shales are visible. Close to Jimboomba, the sandstone is thick-bedded and nodular.

"In Goertz's Selection (No. 20) about three miles south of Jimboomba, I was shown a bed of highly carbonaceous shale, containing streaks of coal, which had been mistaken for a seam of coal.

"The country in the neighbourhood of Tambourine consists almost entirely of brown sandstones.

"From Tambourine up to Lahey's Mill, on Cunungra Creek, nothing but sandstone ridges and black-soil flats are traversed. The higher ridges on either side of the creek are capped with basalt; while, six miles above the mill, the country is almost entirely of basalt.

"Mr. Paine accompanied me over a low gap in the Darlington Range, where there is a break in the basalt, on to the heads of the Coomera River. The country was all sandstone.

"On Back Pine Creek, there is a section of blue and black carbonaceous shale, with streaks of coal, overlying a hardened sandstone, and dipping south-west at 15°.

"Close to Pine Creek, near Selection 31, there is a hill called Meerschaum Mountain, from the fact that a very light white material, somewhat resembling that mineral, can be picked up on its sides. I have not seen this substance *in situ*. This substance is an infusorial earth. Mr. W. A. Dixon, of Sydney, gives the following analysis of it:—

	Per cent.
Moisture and traces of organic matter ... ..	10·31
Oxide of iron and traces of alumina ... ..	0·59
Lime ... ..	traces.
Silica ... ..	89·10
	<hr/>
	100·00

Mr. Dixon says that under the microscope the silica is almost entirely composed of the frustales of diatoms—probably *Melosira arenaria*. I confirmed Mr. Dixon's remarks as far as the microscopical examination went.

"Returning to Tambourine, I next visited Mr. G. A. Ball's Selection (No. 71), on Flagstone Creek, where a seam of coal, about two feet six inches thick, crops out in the banks of the creek. A section across the seam shows:—

	Ft.	in.
Coal ... ..	0	8½
Coaly shale ... ..	0	2
Coal ... ..	0	10
Clay band ... ..	0	1
Coal ... ..	0	10
Coarse grey sandstone ... ..	2	7½

"A small fault, running N. 15° W., across the creek, displaces the seam about two feet. The coal dips S. 30° W. at 12°.

"The following is a proximate analysis of a sample of the coal taken from the cleanest part of the seam:—

	Per cent.
Moisture ... ..	8·1
Volatile hydrocarbons ... ..	38·7
Fixed carbons ... ..	50·7
Ash ... ..	2·5
	<hr/>
	100·0

The coal is a bright non-caking coal; the ash is white.

"The small range between Flagstone Creek and Beaudesert, known as Birnam Range, is of a hard silicified sandstone. On the western fall of this range a great thickness of black and blue shales is visible in the gullies in Mr. W. T. Walker's selection (No. 94).

"In Mr. Rafter's Selection (No. 63) there is a ridge of sandstone running in a northerly direction. The lower part of this sandstone contains a large percentage of iron. In the upper part some of the beds are very soft. I noticed one bed, about nine feet thick, which was a good hard stone, and had apparently withstood weathering action well. I do not think that any of it is of sufficiently good character to pay for carriage as a building stone.

"I was afterwards informed that Mr. Jennings had opened up a small quarry in his Selection to the north of Rafter's, on the same ridge of sandstone, but unless it is of a very superior quality it would not compete with the building stones at present available for Brisbane. The sandstone dips to the east at 24°.

"Below the sandstone, and a little higher up the gully, a seam of coal, with the same dip, and one foot seven inches in thickness, crops out in the bank. It is a good, bright, non-caking coal, without any bands, but it has too high an angle of dip and is not thick enough to pay to work. The section in the gully shows:—

										Ft.	in.
Sandstone	...	...	...	...	...	...	...	...	...	0	0
White clay	...	...	...	...	...	...	...	...	...	0	0
Coal	...	...	...	...	...	...	...	...	...	1	7
Fireclay	...	...	...	...	...	...	...	...	...	0	1½
Laminated sandstone	...	...	...	...	...	...	...	...	...	0	0

"Approximate analysis of this coal gives:—

										Per cent.
Moisture	...	...	...	...	...	...	...	...	...	4.3
Volatile hydrocarbons	...	...	...	...	...	...	...	...	...	13.5
Fixed carbon	...	...	...	...	...	...	...	...	...	71.1
Ash	...	...	...	...	...	...	...	...	...	11.1
										100.0

The ash was of a dark-grey colour.

"A seam of coal crops out in a gully, in Selection No. 137, belonging to Mr. Brayford, about a mile and a half north of Beaudesert. The section in the gully is:—

										Ft.	in.
Fireclay	...	...	...	...	...	...	...	...	...	0	0
Black shale with streaks of coal	...	...	...	...	...	...	...	...	...	0	6½
Fireclay	...	...	...	...	...	...	...	...	...	0	4
Black shale with streaks of coal	...	...	...	...	...	...	...	...	...	0	11
Fireclay	...	...	...	...	...	...	...	...	...	0	3
Coal	...	...	...	...	...	...	...	...	...	0	3
Fireclay	...	...	...	...	...	...	...	...	...	0	3
Brown shale	...	...	...	...	...	...	...	...	...	0	5½
Bright clean coal	...	...	...	...	...	...	...	...	...	1	4
Fireclay	...	...	...	...	...	...	...	...	...	0	9
Coal	...	...	...	...	...	...	...	...	...	0	6½

This is one of the best-looking coals I saw in the district. The dip of the coal is W. 10° N. at 10°. I appended analyses of two samples of this coal, one taken from the outcrop in the gully, and analysed by Mr. Joseph Fletcher, the other from a shaft in Mr. John Waters' Selection (No. 120), and analysed by myself:—

Sample.		Sample from outcrop. Per cent.	Sample from shaft. Per cent.
Moisture	...	8.0	Not determined
Hydrocarbons (volatile)	...	34.0	44.0 (includes moisture)
Fixed carbons	...	33.0	47.3
Ash	...	25.2	8.7
		100.0	100.0

The ash was white. The coal is hard, and has a specific gravity of 1.41. It resembles a cannel coal and burns freely.

"The shaft in Mr. John Waters' Selection was filled in, but I was informed that the coal was much thicker there.

"Another seam crops out about a hundred yards higher up the gully. This is very impure coal; it is more of a coaly shale.

"From Beaudesert I went up the Logan and Palm Creek to within three or four miles of Mount Stanley, about thirty miles south of Beaudesert. The Ipswich beds extended all the way up. I saw no seams of coal. In Mr. Byrne's Selection, on Palm Creek, I was shown a bed of black carbonaceous shale, about fifteen inches in thickness, which had been mistaken for coal.

"Seams of coal have been reported to exist in Christmas and Widgee Creeks, but as I could get no definite information regarding them, I did not visit that part of the country.

"Nothing, it will be observed, has been attempted in the way of trying any of these seams away from their outcrops; the seams are, in no case, of any great thickness, but the analyses of some of the coals show them to be of a fair quality, and I think it would repay the owners of the properties to test them at a shallow depth away from the outcrops.

"I believe that Mr. Downman has done nothing at present to verify, by means of a shaft, the correctness of the results obtained in a borehole put down by Mr. Falconer, a section of which I gave in my previous Report."

J.



## CHAPTER XXVI.

### THE TRIAS-JURA SYSTEM—*continued.*

#### THE IPSWICH FORMATION (UPPER TRIAS-JURA) IN THE TYPE DISTRICT—*continued.*

IN and near the Town of Ipswich, the strata are tilted at high angles, and are accompanied by flows of basalt. I cannot, however, see any clear evidence that the tilting of the strata is due to the igneous rocks. On the contrary, there is every appearance of the latter being interbedded with the former, and having been tilted simultaneously with them.\* On the summit of Limestone Hill, within the Town boundary, two beds of limestone are seen, the uppermost being about ten feet thick, and resting on thirty feet of grey and reddish shales. Beneath the shales is a thick bed of basalt, which, again, rests on a thick bed of limestone. A second mass of basalt is seen beneath the lower limestone bed. The limestones dip at a high angle to the north-east. I am inclined to believe that the upper bed of limestone is, so to speak, "conformably" overlaid by a thick basalt, which, at first dipping with the same high angle as the limestones and shales, gradually flattens out eastward, till its base again rises to the surface on the left bank of Bundamba Creek. The limestone, as seen at its outcrop, is rather the siliceous skeleton of a sandy limestone, and contains frequent kernels of chert. It appears to be quite unfossiliferous. It is described by Gregory as "tufaceous limestone, containing siliceous concretions."

The most important description of the Ipswich Coal Field published up to the present date, although it is one of the earliest, is that of Mr. A. C. Gregory.† This valuable Report, which I find it impossible to abridge very much, deals principally with the character of the various coal-seams. The following extracts are taken from the Report:—

"*Old Moggill Coal Mine.*—The Moggill coal-seam being confined to a small area by the river on the east and south, and by a fault on the west, the available coal was soon worked out, and the mine has been abandoned for about ten years. It is stated that the seam was about six feet thick, but not of a very high class, probably owing to its being worked so near the outcrop.

"*Mr. Lyons' Coal Seam.*—About one mile to the W.S.W. of the Old Moggill Mine, several outcrops of coal are visible, and a shaft has been sunk seventy feet by Mr. Lyons, on Portion 117, and a seam of coal five and a-half feet thick cut at forty-five feet. The coal has several thin bands of bituminous shale, but, rejecting the bands, there would be from three to four feet of good available coal.

"Section taken from the shaft and adjacent outcrops:—

	Feet.
Coarse grit, irregularly stained with iron ... ..	10
Coarse conglomerate ... ..	8 to 10
Coarse sandstone ... ..	20
Hard shales ... ..	15
Coal ... ..	5½
Thin-bedded sandstones and shales ... ..	50
Coal ... ..	1
Thick-bedded coarse sandstones ... ..	over 50

\* See Plate 49, fig. 1.

† Report on the Coal Deposits of the West Moreton and Darling Downs District. Brisbane: by Authority: 1876.

"The strata are nearly horizontal, having a very slight dip to the south-west.

"Following down the gully three-quarters of a mile, there are several small seams in the bottom of the watercourse, and on the southern bank a seam of coal eight feet thick is exposed.

"On the bank of the river, three-quarters of a mile east of the shaft, there is a seam of coal, one and a-half feet thick, at the water level.

"Taking into consideration the relative positions of the outcrop of these seams, it may be inferred that the coal in Mr. Lyons' shaft is the uppermost bed, and that there is a small seam some fifty feet lower, and a thick workable seam a hundred feet deeper, a portion of which, being thrown up by a fault, was worked at the old Moggill Mine.

"The coal is bituminous, moderately hard, cakes a little in coking. Specific gravity, 1.52. A specimen of the better part of the seam gave:—

Volatile in coking	...	...	...	...	...	...	...	...	38
Fixed carbon	...	...	...	...	...	...	...	...	51
Ash	...	...	...	...	...	...	...	...	11
									<hr/>
Total	...	...	...	...	...	...	...	...	100

"*Goodna Mine.*—Crossing the Brisbane River, some thin bands of inferior coal are visible under the sandstone of Mr. Jeay's quarry, just below Woogaroo; and at Goodna a seam of coal crops out, less than a mile from the river.

"This seam, which dips from 3° to 5° to the southward, was originally worked from the outcrop, but now by a shaft ninety feet deep, through sandstone and inferior bands of coal, the workable portion being about four and a-half feet thick. This mine has been extensively worked for about eight years, and has furnished a large proportion of the coal supplied to the steamers on the river and intercolonial traffic.

"The coal is of fair quality, with bright laminar fracture, but rather tender and friable. It cokes well. Specific quality, 1.47.

Volatile in coking	...	...	...	...	...	...	...	...	29
Fixed carbon	...	...	...	...	...	...	...	...	62
Ash	...	...	...	...	...	...	...	...	9
									<hr/>
									100

"This seam of coal is apparently limited on the east by Woogaroo Creek, and on the west by a fault and Redbank Creek, beyond which it again appears in the old Redbank Coal Mine, extending up the River about a mile and a-half to the Six-mile Creek, in which direction it deteriorates both in quality and thickness.

"*Redbank Coal Mine.*—The Redbank coal-seam, though now abandoned, for several years was the chief source of supply in the district. It is nearly horizontal, the dip a little to the south, the thickness varying from three to six feet, with several bands of shale. The outcrop extends for half a mile along the bank of the river. The coal is rather soft, and very similar to the Goodna seam, but not so free from shale and band.\*

"*Six-Mile Creek.*—At the Six-mile Creek, on the Ipswich Road, there is a disturbance in the coal strata, the seams cropping out at a high angle of 30° to 40°, and the coal much mixed with shale, so as to be of no value. The high angle of dip on both sides of the valley is, however, only local, and the shales and sandstones to the west indicate that the coal continues in that direction, with very little dip, as far as Bundamba Creek, while in a southerly direction an anticlinal axis of elevation brings the coal to the surface, with a dip to the north on one side and to the south on the other.

---

\* From the preceding paragraph it appears to be identical with the Goodna Seam. (R.L.J.)

*“Thomas’s Mine.*—At this point Thomas’s Mine has been opened on Portion 270, Parish of Goodna, the workings being on a dip of  $15^{\circ}$  to the south for one hundred and fifty yards. The thickness of the seam is about six feet, of which four to five feet are available, as there are some bands of clay and shale, which vary considerably in thickness. The coal from this seam is hard and bright, and bears carriage better than the average of the district, while it is in good repute as a steam coal. The specific gravity is 1.44.

Volatile in coking	...	...	...	...	...	...	...	...	29
Fixed carbon	...	...	...	...	...	...	...	...	57
Ash	...	...	...	...	...	...	...	...	14
									<hr/>
									100

“It makes a fair coke, but not equal to the coals further to the west, near Ipswich. About two hundred yards to the east of Thomas’s Mine the coal crops out in a gully.

*“Coal Seam in Portion 252, Goodna.*—To the south the seam dips for about a mile, and then rises again at an angle of  $30^{\circ}$ , the outcrop crossing the road on the north boundary of Portion 252; but a hundred yards further south it shows again in a horizontal position, with a thickness of six feet, the outcrop showing along the face of the hill for a quarter of a mile.\*

*“Thomas’s New Coal Mine.*—To the south and west of this outcrop the lower beds of clays and shales are uncovered for a space of about a mile, when the coarse sandstones again appear in horizontal beds, covering a fine seam of coal [the Aberdare], which crops out in Portion 270, parish of Bundamba [Goodna?], where it is worked by Mr. Thomas. The seam is eight to ten feet thick, but only four to five feet of workable coal. At the outcrop it dips  $1^{\circ}$  to the south, but rapidly increases, and at the back of the hill, two hundred yards south, the sandstones dip  $10^{\circ}$  to the south. The coal from this seam is not quite so hard as at Thomas’s Mine, Portion 270, Goodna, but seems to be less mixed with inferior bands. The specific gravity is 1.40.

Volatile in coking	...	...	...	...	...	...	...	...	30
Fixed carbon	...	...	...	...	...	...	...	...	59
Ash	...	...	...	...	...	...	...	...	11
									<hr/>
									100

*“Thompson’s New Coal Mine.*—About half a mile to the northward of Thomas’s Mine, what appears to be the same seam is visible in a gully in the water reserve, and a shaft has been sunk on the adjacent Portion No. 174, Bundamba [Goodna?] by J. M. Thompson, Esq., and an excellent seam of coal cut at forty five feet, the dip being  $17^{\circ}$  to the west. The thickness is from six to ten feet, but there are some bands of shale and inferior coal which will probably reduce the workable portion to five feet. The coal is of a good, bright, reedy character, but rather tender and friable. It cokes very well. Specific gravity, 1.38.

Volatile in coking	...	...	...	...	...	...	...	...	32
Fixed carbon	...	...	...	...	...	...	...	...	62
Ash	...	...	...	...	...	...	...	...	6
									<hr/>
									100

“This small proportion of ash and large percentage of carbon places it at the head of the Ipswich coals, both as a steam coal and for coke.

\* This and the seam referred to in the preceding paragraph appear to be one and the same. (R.L.J.)

"The dip of the seam being to the north-west, it passes under Bundamba Creek, at a distance of four hundred yards, and the opposite bank rises into an undulating tract of basalt, having a length of four miles from the Bremer River south-westerly, and a breadth of two miles from Bundamba Creek to the boundary of the Town of Ipswich; and as the Carboniferous strata are found to dip and pass under the basalt along the whole of the margin of the igneous rock, it may be inferred that the coal beds are only interrupted by the fissures through which the basalt has been erupted.

"*Coal at Mihi Creek.*—Crossing to the north-west of the igneous tract, the Carboniferous rocks are found rising to the surface in the Town of Ipswich, and several small seams of inferior coal are exposed in the cuttings for railway and roads; and at the junction of Mihi Creek with the Bremer River, two large seams of coal crop out, the upper being exposed in the bed of the river, the adjacent Railway Cutting, and at the top of the hill on the Pine Mountain Road, the outcrop trending north-east towards the Tivoli Mine. In the Railway cutting the dip is  $14^{\circ}$  to the S.S.E. The quality of this coal is inferior, and evidently much disturbed at the outcrop, and the beds of sandstone and shale vary considerably in thickness in the space of a few yards.

"*Eastwood Mine.*—The second seam is about a hundred feet below that exposed in the Railway cutting, the outcrop showing in the gully under the Railway Bridge. It has a thickness of seven feet, but there are several thin bands of shale. This seam is worked at a point about three hundred yards to the N.N.E. by Messrs. Archibald, as the Eastwood Mine, where the dip is  $7^{\circ}$  to the S.E. The coal is bright and bituminous, but very soft, and breaks small in carriage. It cokes well. Specific gravity, 1.4.

Volatile in coking	...	...	...	...	...	...	...	...	25
Fixed carbon	...	...	...	...	...	...	...	...	63
Ash	...	...	...	...	...	...	...	...	12
									<hr/> 100

"*Tivoli Mine.*—On the line of outcrop of the upper seam, at the distance of one and a-half miles, is the Tivoli Mine, which is worked by a drive of six hundred yards on a dip of  $14^{\circ}$  to the S.S.E., the thickness of the seam being five to six feet. The coal is bright and bituminous, very tender, breaking into small cubical pieces so easily as to scarcely bear carriage. It, however, makes excellent coke. Specific gravity, 1.35.

Volatile in coking	...	...	...	...	...	...	...	...	27
Fixed carbon	...	...	...	...	...	...	...	...	66
Ash	...	...	...	...	...	...	...	...	7
									<hr/> 100

"*Blond and Wright's Seam.*—The outcrop of a thin bed of sandstone, which covers the Tivoli seam, leads about a quarter of a mile east to Blond and Wright's Mine, which is worked on the same seam, on a dip of  $15^{\circ}$  to the S.S.E. The coal is a little harder than at the Tivoli Mine, but in other respects not of equal value. Specific gravity, 1.32.

Volatile in coking	...	...	...	...	...	...	...	...	26
Fixed carbon	...	...	...	...	...	...	...	...	57
Ash	...	...	...	...	...	...	...	...	17
									<hr/> 100

"On the north-east side of these workings a fault occurs, and the seam is thrown downwards, and worked at a lower level on both sides of the road, on the descent to Sandy Creek. The quality of the coal does not improve in this direction.

"*New Mine.*—About a quarter of a mile to the north of the Tivoli Mine, a seam of coal has recently been opened, showing a thickness of eight feet, but some bands of

inferior quality reduce the workable coal to six feet. The dip is  $11^{\circ}$  to the S.S.E., and would apparently pass one hundred feet below the Tivoli seam. This seam is probably identical with the seam of the Eastwood Mine. The coal is moderately hard. Specific gravity, 1.34.

Volatile in coking	...	...	...	...	...	...	...	...	31
Fixed carbon	...	...	...	...	...	...	...	...	61
Ash	...	...	...	...	...	...	...	...	8
									<hr/> 100

*"Coal Seam on Brisbane River.*—Two miles north-west from the Tivoli Mine, a large coal-seam is exposed on the bank of the Brisbane River, just above the Rocky Crossing. The total thickness of the seam is nearly thirty feet, but so full of bands of shale that only three feet of the lower part could be worked, and even that of such inferior quality that it would be of little value as fuel. A specimen from the best part of the seam gave the following results. Specific gravity, 1.47.

Volatile in coking	...	...	...	...	...	...	...	...	22
Fixed carbon	...	...	...	...	...	...	...	...	51
Ash	...	...	...	...	...	...	...	...	27
									<hr/> 100

"In the gullies to the south-east of this outcrop the coal-seam shows with a reduced thickness of ten feet, of which five to six feet would be workable, though not of very good quality; but it is probable that it improves to the southward, as it recedes from the Pine Mountain, where the coal strata are tilted up at high angles by the older serpentine rock, which forms the anticlinal axis of the mountain.

"The whole of the hereinbefore described seams of coal are of the bituminous class, and are associated with coarse sandstones and arenaceous shales. The weight of evidence is in favour of the assumption that the whole of the workings are confined to two main seams, principally the upper one, and that the difference in the quality of the coal raised from each mine has some relation to the distance from the northern margin of the coalfield; and it may be inferred that the drift from the high ranges of Devonian rocks deposited more earthy matter along the margin than in the more distant and central portions of the great valley in which the coal was originally formed.

*"Coal near Walloon.*—Following the general course of the Railway from Ipswich to Toowoomba, the first indications of coal are observable a little beyond Walloon Station, where small blocks of coal are observable in the bed of a watercourse descending from the range in the Rosewood Scrub. Coal shales are visible in banks of the gullies, and just below the basaltic cap of the range beds of black carbonaceous shale are exposed, while the soil is mixed with fragments of hard, bright coal, indicating the proximity of a seam of good coal, though the outcrop was not found. The character of this coal is quite distinct from the bituminous coals worked near Ipswich, being very hard, not subject to injury by exposure to the weather, less brilliant in fracture, and does not cake much in coking. The volatile portion usually exceeds forty five per cent., producing a large proportion of oil or gas, according as it is subjected to a low or high temperature in distillation, and it may be observed that these characters apply to almost all the coal-seams to the west of this locality. The coal has a specific gravity of 1.30.

Volatile in coking	...	...	...	...	...	...	...	...	47
Fixed carbon	...	...	...	...	...	...	...	...	36
Ash	...	...	...	...	...	...	...	...	17
									<hr/> 100

*“Coal near Rosewood Station.*—Coal is reported to have been found near the Rosewood Station, but that the seam is only one and a-half feet thick, though of excellent quality. About three miles beyond Rosewood, and a mile north of the Railway, two small seams of coal were found in the shales on the bank of a watercourse descending from the range, but neither of any value. The coal strata here rest on limestone containing coals of the mountain limestone series,\* but the actual junctions of the two series of rocks were not visible, the Carboniferous rocks being overlaid by basalt, which forms the summit of the range

*“Coal on Blackfellow's Creek.*—Although the Railway cuttings through the Little Liverpool Range show some good sections of the coal sandstones and shales, no coal has been found, and it seems that the coal is covered in this locality by a great thickness of shales and coarse sandstones, similar to those to the east of Ipswich, and as these strata dip from the summit of the range to the west, it is not till Blackfellow's [Tenthill] Creek is reached that there is any good natural section of the strata exposed; but here a thin seam of coal with carbonaceous shale is visible on the bank of the creek, ten miles south from Gatton Station, and twelve miles higher up the creek a fine seam of excellent coal crops out in the west bank, just above the upper boundary of Portion No. 9. This seam contains nine feet of workable coal, the top being a seam of coal one foot, then one foot fireclay, six feet of coal, one foot white clay, one foot coal, one foot clay-shale, one foot coal, resting on a thick bed of fireclays and shales. Above the coal, fireclay and thin bands of shale are visible, which are again covered by a mass of basalt, which rises about a thousand feet to the summit of the Great Dividing Range. The coal is nearly horizontal at its outcrop. It is a very hard cannel coal, with cubic fracture, does not cake in coking. Specific gravity, 1.29.

Volatile in coking	...	...	...	...	...	...	...	...	47
Fixed carbon	...	...	...	...	...	...	...	...	36
Ash	...	...	...	...	...	...	...	...	17
									100

*“Coal, Flagstone Creek, near Toowoomba.*—In the valley of Flagstone Creek, eight miles south-west from Helidon Railway Station, and six miles from Toowoomba, on Portion No. 44, there is a good seam of coal, which has been opened on the south side of the creek by a drive of five or six yards, showing a thickness of fifteen inches; but in the gully, a hundred yards south, the thickness is two feet. The same seam is also exposed on the north side of the valley, but only one foot thick. This coal is moderately hard; does not cake in coking. Specific gravity, 1.36.

Volatile in coking	...	...	...	...	...	...	...	...	36
Fixed carbon	...	...	...	...	...	...	...	...	48
Ash	...	...	...	...	...	...	...	...	16
									100

“About two miles to the west of this outcrop of coal a large deposit of rich iron ore shows at the junction of the Carboniferous rocks and the superincumbent basalt, and within a few yards limestone of impure description, apparently a tufa derived from the igneous rock.

*“Coal near Murphy's Creek.*—Two miles north from Murphy's Creek Railway Station, many small pieces of coal were found in the bed of a small watercourse, and it is reported that a thin seam of coal has been found in the adjacent valley, but that it is not of sufficient thickness to be of any great value.

\* See remarks *postea*, p. 343.

"Although there are numerous deep cuttings in the Carboniferous rocks of the Main Range along the line of the Railway between Murphy's Creek and Highfields, yet no coal-seams have been exposed, though this may in some measure be accounted for by the line following nearly along the outcrop of a thick bed of sandstone, which has a very gradual rise towards the summit of the Main Range, and passes under the basalt which forms the watershed between the eastern and western waters.

"*Coal at Spring Creek.*—Crossing the basaltic tract to the westward, the first point where the Carboniferous strata are visible is at Spring Creek, near the Warwick Railway, six miles west from Toowoomba. Here a thin seam of coal has been cut in sinking a well, and a seam three inches thick, accompanied by black shales and iron-stones, are exposed in the bed of the creek; but the strata being nearly horizontal, they soon pass under the basalt again on all sides, so that there is no great thickness of the sedimentary strata exposed in section.\*

"*Coal, Hodgson's Creek.*—Six miles W.S.W. from Cambooya Railway Station, in the bed of Hodgson's Creek, large blocks of coal, some exceeding 1 cwt., have been drifted out of the waterholes; and the Carboniferous shales and soft sandstones are largely exposed on the west side of the creek, extending nearly ten miles to the south-west. The coal is found along the channel of the creek for a distance of two miles, in a condition which indicates that it has only moved a few yards from the original seam. This coal is of excellent quality, being hard and capable of standing carriage and exposure to wet without injury. It does not make good coke. Specific gravity, 1.33.

Volatile in coking	...	...	...	...	...	...	...	45
Fixed carbon	...	...	...	...	...	...	...	42
Ash	...	...	...	...	...	...	...	13
								100

"*Clifton Coal.*—The Clifton Coal Mine is situate two miles beyond the Clifton Railway Station, close to the east side of the line. Two shafts have been sunk, and a bed of coal four to five feet thick is worked at a depth of sixty feet. A second seam of two feet at eighty feet, and a third of one and a half feet at one hundred feet, have been cut in the principal shaft.

"The Upper Seam, which is the one worked, produces good coal, varying from bright bituminous to dead black oil coal, all being very hard and tough, so that it bears carriage without breaking. It produces a high percentage of gas or oil, according to the mode of treatment. Specific gravity, 1.26 to 1.35.

Volatile in coking	...	...	...	...	...	...	...	48
Fixed carbon	...	...	...	...	...	...	...	42
Ash	...	...	...	...	...	...	...	10
								100

"The Second Seam is better suited for coke, as it cokes [cakes?] in heating.

"The Lower Seam is very hard oil coal. Specific gravity, 1.32.

Volatile in coking	...	...	...	...	...	...	...	47
Fixed carbon	...	...	...	...	...	...	...	37
Ash	...	...	...	...	...	...	...	16
								100

\* It may be remarked that this spot is nearly on the same level as the junction of the basalt and stratified rocks near Highfields, on the east of the Range, so that the bottom of the basalt appears to be pretty level in this locality. Mr. Gregory's Geological Map shows that the basalt extends many miles further west, and at their western boundary they form no escarpments, but appear to dip under the western members of the Ipswich Formation. (R.L.J.)

"Situate in an extensive tract of open, nearly level country, the strata seem to have but little inclination, but the general dip seems to be a little to the west. To the eastward the coal rocks are covered by basalt, the edge of which is between the two shafts of the mine, the eastern one being sunk through a considerable thickness of hard blue metal, and at the junction of the igneous and coal rocks a bed of earth was found containing fragments of fossil wood, with the leaves and seed vessels of plants, belonging to a period much more recent than the coal strata."

The Writer visited the Clifton Colliery, while it was being worked, in 1880, and measured the following section of the Upper Seam:—

	Pt.	in.
Black clay shale ... ..	1	0
Coal (thickens to 7 inches) ... ..	0	1
Grey fireclay ... ..	0	1½
Grey fireclay, with five thin seams of coal ... ..	0	3
Coal ... ..	0	2
Grey fireclay, with white spots with a thin coal-seam ... ..	0	1
Coal ... ..	1	10
Stiff grey clay ... ..	0	3
Coal ... ..	1	10
Fireclay ... ..	20	0

According to Mr. Gregory's observations it may be surmised that the eastern shaft alone passes through "a considerable thickness" of basalt, before cutting the coal. As the dip of the coal is to the west it may be presumed that this mass of basalt (which is unconnected with the main mass of the Toowoomba Range) occupies a local hollow, or possibly an ancient valley. The basalt may even be of a later age than the basalt of the Main Range.\* Mr. Gregory continues:—

"Coal has been found in Clifton Creek to the north-west of Clifton Mine; also in a well sunk through basalt at the head station, while the Carboniferous sandstones and shales are largely developed to the south-west.

"*Coal near Allora.*—Coal was worked near Allora, about two miles from the Hendon Railway Station, and the coal supplied for use in the locomotives on the Warwick Railway. The seam was not more than two feet thick, and has been abandoned.

"*Warwick.*—The Town of Warwick is situated on an outcrop of the Carboniferous sandstone, containing great quantities of fossil wood, changed mostly to iron ore; and to the east and north of the town the soft shales indicate the probability of coal existing at a small depth, small fragments of it being found five miles to the south-east of the town; also in a well on the Agricultural Reserve.

"*Coal at Farm Creek.*—On Farm Creek, fourteen miles east from Warwick, the outcrop of a large seam has been worked for the supply of the steam mills.

"*Character of the Coal, &c.*—The general character of the coals found between Walloon and Warwick is that of cannel coal. It does not cake in coking, gives a high percentage of gas, or oil and paraffin, according to its treatment at a high or low temperature. Its hardness renders it very suitable for export. It burns very freely, and leaves a soft, white ash. From the small proportion of fixed carbon, and its not caking, it does not produce good coke, but a charred coal, which, however, burns well; consequently it is not well adapted for blast furnaces, though well suited for reverberatory furnaces. As a steam coal it is best suited for stationary or marine engines, the strong blast of locomotives being apt to blow it through the tubes. It is a very high-class household coal.

\* Vide my Colleague's remarks on the Plant-remains referred to by Mr. Gregory. (R.L.J.)





	Pt.	in.
Coal ... ..	0	11
Band ... ..	0	4
Coal ... ..	1	4
Bands of clay and worthless coal	1	1
Coal ... ..	1	7½
Band ... ..	0	0½
Coal ... ..	0	7
Band ... ..	0	2
Coal ... ..	3	6

The dip is 13° to S. 74° W. The lower seam (about six feet) is first worked, after which the "tops" are taken down. In the new tunnel the dip is 12° to west and south of shaft 20°.\*

*Mount Pleasant.*—This is a seam worked by Messrs. Stafford and by the Borehole Company in adjoining land. It is probably one of the seams being worked (by Messrs. Green and Jones), or cropping out in Mr. Allen's property adjoining. The dip is 1 in 3 W. 10° S.

	Pt.	in.
Coal ... ..	0	8
Intermittent band of ironstone boulders	0	8
Coal ... ..	1	0
Band ... ..	0	1
Coal ... ..	2	9

*Seams in Allen's Paddock, Goodna.*—In this property several seams of coal are worked by Messrs. Green and Jones, of which the following is an approximate section:—

	Pt.	in.
Seam (h) ... ..	4	0
Strata ... ..	60	0
Seam (g) with two small bands	3	0
Strata ... ..	22	0
Seam (f), coarse, only two feet being workable	8	0
Strata ... ..	12	0
Seam (e) ... ..	2	6
Strata ... ..	60	0
Seam (d) ... ..	0	0
Strata ... ..	60	0
Seam (c) ... ..	0	0
Strata ... ..	150	0
Seam (b) ... ..	0	0
Strata ... ..	80	0

Seams (c) and (d) crop out in the paddock with a dip of 30° to 33° W.

*Scarborough's Seam* is four feet in thickness, with three small variable bands, irregular in thickness and position. It is worked at the Day Dawn Mine, Parish of Goodna.

*Stafford's Seam* (which, however, is not the same worked by Messrs. Stafford) adjoins Scarborough's Seam. Its thickness varies from two feet six inches to four feet. It has many small dislocations, and usually two thin bands.

*The Ebbw Vale Seam*, near Dinmore, has a thickness of three feet four inches, with a band of ironstone boulders in the middle. It dips at 10° to 15° to E. 10° N.

\* I cannot be certain whether this is the same seam as that referred to by Mr. Gregory in the heading of "Thomas's New Coal Mine," which is called the Aberdare by the Rev. Mr. Tenison Woods. (R.L.J.)



In his Pamphlet on "The Coal Resources of Queensland,"\* the late Rev. J. E. Tenison Woods gave the following particulars:—

"*Waterstown Mine*.—This is a colliery which is being worked by two or three shafts, all on the north side of the Bremer, and very close to its banks, and where it is navigable for small craft. There is a shaft upon the Garden Seam, which is about seven feet thick, and crops out upon the surface. It has a dip of usually 1 in 5 S. 15' 20° E. The coal has a short fracture, breaks into small cubes, soils the fingers, and is full of bright bituminous streaks. Of the coal from this mine Mr. A. C. Gregory reports:—"The coal is a fairly hard coal, cokes well, and is a good steam coal." The following is the analysis:—

Fixed carbon	...	...	...	...	...	...	...	62.0
Volatile hydrocarbons	...	...	...	...	...	...	...	25.2
Ash	...	...	...	...	...	...	...	12.8
								100.0

"Above the seam there is about four and a-half feet of splendid fireclay. The seams connected with the Waterstown Coal Field are the Edina, Eclipse, Tivoli, and Old Tivoli. The Bell Seam, which is about a mile from the Garden Seam, and belonging to the same proprietor (Mr. Moffatt), is about three and a-half feet thick. It seems a more compact coal than the last, and is a first-class coal for steam, gas, and coaking. It is worked by a drive like the Garden Seam, about two hundred yards long, and dipping 16°, which is the dip of the seam, the direction being S. 15° E. There is supposed to be a fault between this seam and the Garden Seam. A seam which crops out near the latter, and which has thinned out, may be the same. Its true position is supposed to be one hundred and fifty feet below the Garden Seam. A new drive has been made on the outcrop (supposed) of the Garden Seam, about a quarter of a mile from the pit referred to last. It is extremely good coal, with scarcely any partings in the seam.†

"On this property there is a large coking kiln which has been in operation some eight years, and during which some four or five thousand tons of coke have been turned out. The coke is made from the very fine slack and dust. It is of splendid quality, and is exported to Rockhampton, Maryborough, and even Melbourne, to the iron foundries. It sells in Brisbane at about £1 17s. 6d. per ton.‡

"*Rossend*.—The Rossend Mine (Lindsay's) adjoins this property. It is worked by one shaft, to the extent of about 20 tons daily, on what is supposed to be the Bell Seam.

"*Tivoli*.—The Tivoli was until lately extensively worked, as its proprietor had the railway contract, and was able, by a short tramway with a steep incline and shoot, to load all the lighters on the river. He has now the contract for the Australasian Steam Navigation Co., and finds it more convenient to work on another seam on the south side of the river. On the Tivoli Mine there is one shaft and three seams. The Eclipse Mine works on one seam of the old or original Tivoli."

Of the portion of the field above referred to, the late Mr. Tenison Woods further remarked:—"There are probably five different seams at present worked. These are: (1) Garden Coal; (2) Edina Coal; (3) Tivoli; (4) Old Tivoli; (5) Bell Coal. No data can be given as to the distances of these seams from one another.

\* 8vo. Brisbane, 1883. Attention should have been called in a previous chapter to two pamphlets by the late Rev. J. E. T. Woods on the Burrum and Burnett Districts, viz., "Lecture on the Burrum Coal Field" (pp. 12, 8vo., Maryborough, 1881) and "The Carboniferous Rocks of the Lower Burnett: A Lecture delivered at Bundaberg on Friday, May 20th, 1881" (pp. 4, 8vo., Bundaberg, 1881).

† Mr. Gulland believes the position of the Waterstown Seam to be five hundred feet above the Tivoli Seam. (R.L.J.)

‡ The manager of the Toowoomba Gasworks informed me, in 1880, that the Waterstown coal yielded at the Works 9,200 cubic feet of gas. (R.L.J.)

"*New Chum Shaft*.—At Bundanba there is a colliery worked by a pit (New Chum Shaft), the property of Mr. Gulland. The shaft is about two hundred and twenty feet deep, tapping two seams, the lower one of which only is worked. The latter shows in all about twenty-seven feet of carbonaceous matter, but of this four feet to four feet eight inches is good clean coal, without any partings or shale. The dip is about 1 in 9, a little east of south. It is a good, firm, shining coal, with much mother-of-coal in the partings; yet it does not soil the fingers as much as other coals on this field. It is entirely sold for steam purposes, with the exception of the slack, which finds a ready market for smith's work.\*

"*Braeside*.—The Braeside Shaft is a mine of Mr. Lindsay's, rather over a mile from the New Chum. The workings are a drive along the seam, which is three feet thick. The coal is very similar to the last. The drive is two hundred and eighty yards long. There is another shaft close by, sixty yards deep, on a second seam of a superior coal.

"*Southern Coalfields*.—All around Pine Mountain and Peak Mountain ("Flinder's Peak" on maps), and for a distance of many miles to the south and west, there are outcrops of coal.

"*Walloon Coal*.—About six miles west of Ipswich is the Walloon Colliery. The seams are three in number. The first crops out on the surface, with a dip, to the south-west, of 1 in 9. The seam is remarkably compact, with about four and a-half feet of coal. The second seam is fifty feet below, with five feet six inches of good coal. A third seam is found forty feet deeper, about five feet thick. This coal differs completely from all the other seams found around Ipswich.† It is perfectly clean and compact, and does not soil the hands. It is not brittle, so that there is little or no slack in the handling. It has a smooth, bright, jet-like lustre, with bright bituminous streaks. As a gas coal it has no equal in the Colony, and also as a household coal. The average of a number of proximate analysis would give a percentage of—

Fixed carbons ... ..	50
Hydrocarbons ... ..	40
Ash ... ..	6
Loss, moisture, &c. ..	4
100	

"Some specimens do not coke well; others yield about 50 per cent., bright and well swollen up. The seam is worked by a drive which runs in a south-westerly direction for about one hundred and thirty-two yards, with a dip of about 1 in 7. The drive, at the present, opens into three levels, the lowest of which is about seventy-five feet from the surface. At this level a magnificent seam of coal, five feet thick on the clear, is met with, and is intersected with a layer of fireclay of about three inches in thickness.‡

"A coal seam, known as 'Morgan's,' crops out about seven miles north-north-east of Warwick."§

## J.

\* The two seams, I was informed by Mr. Gulland, the proprietor, are separated by two hundred feet of shale and sandstone. (R.L.J.)

† It is not the seam near Walloon referred to by Mr. Gregory. (R.L.J.)

‡ This is, I presume, what is now known as Rea's, or the Caledonian Seam. (E.L.J.)

§ Some good sections of seams and analyses of coal will be found in a pamphlet, "Queensland, Australia; its Territory, Climate, and Products" (pp. 117, plates, &c., 8vo., London, n.d.), issued by the late Mr. Richard Daintree, C.M.G., when Agent-General in London. (See pp. 77-80). (R.E. Junr.)

## CHAPTER XXVII.

### THE TRIAS-JURA SYSTEM—*continued.*

#### THE IPSWICH FORMATION (UPPER TRIAS-JURA), IN THE TYPE DISTRICT—*continued.*

The outcrop of a nine-inch seam of poor shaly coal is seen in the railway cutting (Brisbane Valley Branch) south of the bend of the Brisbane River, south-east of Lowood Station. It lies beneath a thick bed of sandstone, and overlies a considerable thickness of soft sandy shales and thin bedded sandstones. The strata undulate gently, but dip, if anything, to the east.

A well in Portion 473 (D. Kennally's), Parish of Walloon, gives the following section:—

	Feet.
Surface (sand and boulders of basalt, &c.)	50
Decomposed sandstone	10
Brown ferrugino-calcareous sandstone, with plants	10
Coal	3
Fine conglomerate and grey sandstone	67
	140

The dip of the strata is about 1 in 12 to the east. The water in the well is rather salt.

In the whole of the Rosewood District, within a circle of five miles radius of the Town of Marburg, the strata consist, for the most part, of sandstones and shales, with beds of red hæmatite nodules; but there are very few continuous sections. A landslip, which took place owing to the heavy rains of the beginning of the year 1890, exposed a two feet bed of limestone on Portion 518 (Gadischki's), Parish of Walloon. The strata are, on the whole, nearly horizontal, and are surmounted by isolated cappings of basalt, forming the higher hills of the district.

A series of very remarkable landslips took place in the Rosewood Scrub District in the beginning of 1890, following on a wet season of unprecedented severity. In this district the primeval "scrub" or jungle had been cleared, and the land settled and cultivated by a colony of German farmers. The great depth of soil, which was often of a clayey nature, had been saturated with water till it became semi-liquid mud, and travelled down the slopes of the hills. At least a hundred acres of land "travelled" more or less on different farms. In some cases the lateral movement was as much as a hundred feet. The removal of the scrub was one of the most powerful predisposing causes of the ruinous havoc. The superficial layer of soil, though held together for a time by the roots of the growing crops, was finally rent asunder into huge crevices like those on a glacier.

After the landslips had taken place, it was constantly to be remarked that springs and gullies, which before the floods had been sources of fresh, or nearly fresh water, had become so highly charged with saline solutions as to be unfit for drinking. This could only mean that the water which in ordinary seasons penetrated the crust of the earth percolated only through strata from which the soluble salts had been already

removed, while in a very wet season strata still retaining undissolved salts were washed by the water. Indeed the quality of the water met with in most of the deep shafts in the Ipswich Coal Field shows that the strata are highly charged with salts.

The Ipswich Coal Measures fossils are exclusively the remains of land vegetation or of marsh or river mollusca, with the exception of the Insect-remains afterwards referred to, while on the other hand the strata of the Rolling Downs teem with the remains of marine animal life. Even the limestones of the Ipswich Formation have yielded no trace of marine organisms. We are forced, from this circumstance, as well as from the saltiness of the strata of the Ipswich Formation, to conjecture that the latter was for the most part deposited in an inland lake. It must be remembered that some lakes, especially such as have no outlet, are much saltier than the ocean.

My Colleague casually examined the beautiful Collection of Plants made by Mr. J. H. Simmonds, of Brisbane, in August, 1890. Amongst the specimens he recognised several Insect-remains and one very beautiful *Estheria*. These have since been described in detail, and it may be well for me to point out that they certainly, to some extent, bear out the above opinions.

The output of the Ipswich Coal Field from 1860 to 1890, inclusive, is estimated at 2,339,013 tons of coal, valued at £1,048,649. It is possible, however, that between 1860 and 1883 a small proportion of the output credited to Ipswich was produced at the Burrum. On the other hand, it is more than likely that a portion of the coal from Clifton may not have been included in the returns, as the products of this colliery were to some extent consumed locally.

#### YIELD OF IPSWICH COAL FIELD.

Year.				Tons of Coal Raised.	Value. £	
1860 to 1883 ...	...	...	...	814,407	...	414,368
1883 ...	...	...	...	98,310	...	49,114
1884 ...	...	...	...	114,577	...	56,475
1885 ...	...	...	...	180,744	...	71,258
1886 ...	...	...	...	189,608	...	72,054
1887 ...	...	...	...	193,286	...	71,851
1888 ...	...	...	...	254,778	...	97,851
1889 ...	...	...	...	217,240	...	95,202
1890 ...	...	...	...	276,063	...	120,476
Totals ...	...	...	...	2,339,013	...	1,048,649

Of the Jimbour coal the Hon. A. C. Gregory reports as follows\* :—

"At the Dingo Point Well the shaft has been sunk through seventy-six feet of surface soil, then three and a-half feet of impure coal which would make a safe roof, when a seam of coal eight feet thick, but with five bands of shale having an aggregate of one foot, leaving seven feet of workable coal, under which there is thirteen feet of fireclay and shale, and a second coal-seam four feet thick, with three thin partings of clay. But the lower seam, in consequence of water in the shaft, could not be fully examined.

"The dip of the coal, so far as could be ascertained in the small space of the shaft, is about 3° to the S.S.E., in which direction a dyke of basalt shows on the surface about a quarter of a mile distant.

\* Brisbane : Watson, Ferguson, and Co. : 1884.





*Ipswich Coals.*

Ipswich Coals.										Lb.
Waterstown, Ipswich—										
Coal burnt	...	...	...	...	...	...	...	...	...	100
Water evaporated	...	...	...	...	...	...	...	...	...	499
Ash	...	...	...	...	...	...	...	...	...	18
Thomas', Bundamba—										
Coal burnt	...	...	...	...	...	...	...	...	...	100
Water evaporated	...	...	...	...	...	...	...	...	...	507
Ash	...	...	...	...	...	...	...	...	...	15
Walloon Coal—										
Coal burnt	...	...	...	...	...	...	...	...	...	100
Water evaporated	...	...	...	...	...	...	...	...	...	457
Ash	...	...	...	...	...	...	...	...	...	15
Tivoli Coal, best—										
Coal burnt	...	...	...	...	...	...	...	...	...	100
Water evaporated	...	...	...	...	...	...	...	...	...	561
Ash	...	...	...	...	...	...	...	...	...	10
Tivoli Coal, second—										
Coal burnt	...	...	...	...	...	...	...	...	...	100
Water evaporated	...	...	...	...	...	...	...	...	...	499
Ash	...	...	...	...	...	...	...	...	...	12

*New South Wales Coals.*

<b>"Waratah," Newcastle, New South Wales—</b>								
Coal burnt	...	...	...	...	...	...	...	100
Water evaporated	...	...	...	...	...	...	...	505
Ash	...	...	...	...	...	...	...	7½

**"TEST OF AVERAGE FROM ALL PARTS OF THE JIMBOUR COAL SEAM, FOR OIL, &c.**

			lb.	per cent.
Coal distilled in retort	...	...	72	100
Coke remaining in retort	...	...	3½	47
Oil, S.G. 0·975	...	...	12	16·7
Ammonia, Water	...	...	5½	7·6
Uncondensed Gas, &c.	...	...	20½	28·5

"The coal does not coke, and is not suited for coke or smiths' forges and similar work. Average specific gravity, 1·275."

The output of the Jimbour Coal Field is given in the "Annual Report of the Department of Mines" for 1885 as 2,040 tons, valued at £1,020.

The exact line of demarcation between the Ipswich and Rolling Downs Formations has not yet been satisfactorily traced, but there is reason to believe that the former gradually passes upward into the latter on the inland side of a line running north-westward from the heads of the Macintyre to Dulacca Railway Station. Beyond that line the presence of marine Cephalopoda and Pelecypoda sharply define the transition from inland or freshwater to marine conditions.

Whether the Ipswich Coal Field can be traced beneath any large area of the Rolling Downs Formation is a question which may in the next century assume an importance comparable to that of the presence of coal beneath the Cretaceous rocks of Kent. So far, none, or only one or two of the deep bores for artesian water in the west have reached the bottom of the Rolling Downs Formation. The latter, in the north and west, directly overlies the older schists, so that the absence of the Ipswich Formation there is certain. Its absence may be due rather to an upheaval at the end of the Ipswich Period than to the thinning out of the strata.

# BASALT AND OTHER IGNEOUS ROCKS ASSOCIATED WITH THE IPSWICH FORMATION.

The relation of the basalt of Mount Tambourine to the Ipswich Formation is well shown by the remarks made by Mr. Rands on the junction-line between the schists and Ipswich Formation. The straight junction-line between the two formations can hardly be anything else than a line of fault, and the basalt overlies not only the portion of the Ipswich Beds seen in that neighbourhood but also the schists and the still more recent fault. To the south and east the basalt directly overlies the schists in the Macpherson Range, and in outlying patches between that range and Burleigh Heads.

In the Toowoomba Range the bedded basalt overlies a portion of the Ipswich Formation, and presents a succession of steep escarpments to the east. Outlying patches of basalt, overlying members of the Ipswich Formation, apparently on a lower horizon, form "The Knobby" and other hills in the Rosewood Scrub. To the west of the Toowoomba Range, the basalt beds form no escarpments, but sink beneath an accumulation of strata, separated indeed from the Ipswich Coal Measures of the other side of the range by an unconformability and an immense outburst of basaltic lavas, but still apparently belonging to the same series and characterised by the same fossils. To this western series belong the Coalfields of Jimbour and Clifton, which are, therefore, on a higher horizon than the Ipswich Coal Field proper.

The basaltic lava-flows, therefore, were poured out after the deposition and partial upheaval of a great part of the Ipswich Coal Measures, and were subsequently covered by a considerable thickness of strata still belonging to the period grouped, from lithological similarity and similarity of organic remains, as the Ipswich Formation. In short, they are contemporaneous with the Ipswich Formation.

It is a mistake to suppose that the whole of the basalts comprised within the area occupied by the Ipswich Formation form one continuous series. In the neighbourhood of Ipswich, masses of basalt are clearly interbedded with the stratified rocks. (See Plate 49, fig. 1.) At Clifton and elsewhere masses of basalt appear to occupy local hollows in the stratified rocks.

Mr. Rands describes the basalt of Tambourine Mountain as amygdaloidal on its upper surface, as including large patches of obsidian and pitchstone, as being "generally full of olivine crystals," and as being occasionally columnar, the hexagonal pillars being often twenty feet in length and three to four feet in diameter.

Mr. Rands describes \* a mass of trachytes containing beautifully developed crystals of sanidine felspar, as occurring in railway cuttings between Logan Village and Beaudesert, near Walton Station. It appears to have come up through the Ipswich Coal Measures, and to have flowed over a portion of them, as shown in the Section Pl. 49, fig. 3. A similar rock is described as occurring about a mile west of Walton Station, "apparently interbedded with the Ipswich Beds." Mr. Rands classes these trachytes in his Albert and Logan Report as "Older Volcanic"—*i.e.*, older than the Toowoomba and Tambourine basalt—and it appears to me on insufficient grounds. There can be little doubt, from the Geological Map attached to the Report, that the trachytes occur among strata, which are on a higher horizon in the Ipswich Formation than those on which the basalt of the Tambourine Mountain rests, and, whether interbedded or intrusive, they are not necessarily older, and may even be newer.

Referring to the basalt, Mr. A. C. Gregory says † that "the carbonaceous sandstones and black shales are visible in the ravines within a quarter of a mile of the highest

\* Report on Logan and Albert, 1889.

† Report on the Coal Deposits of the West Moreton and Darling Downs Districts. Brisbane: by Authority: 1876.

part of the Great Dividing Range, but are then covered by basalt from a hundred to eight hundred feet in thickness, and having a minimum breadth of seven miles, beyond which the sandstones emerge in horizontal beds, so closely resembling those on the eastern side that it may be inferred that they are only interrupted along the fissures through which the basalt has been erupted." It will be observed that Mr. Gregory says nothing of the reappearance of the basaltic escarpments on the western side of the Range.

Our ideas of the relation of the basalt to the Ipswich and other Formations are shown by the Diagram-Section, Plate 49, fig. 2.

### LIFE OF THE PERIOD.

The following is my Colleague's List of Fossils from the type district of the Ipswich Formation:—

Kingdom—PLANTÆ.  
Section—CRYPTOGAMIA.  
Class—ACOTYLEDONES.  
Order—CALAMARIÆ.  
Family—EQUISETACEÆ.  
Genus—EQUISETUM, Linnæus.

*Equisetum rotiferum*, Ten. Woods.

Loc. Walloon. Also occurs at Stewart's Creek, Rockhampton.

*Equisetum ? latum*, Ten. Woods.

Loc. Esk Valley. Also occurs at Rosewood, Rockhampton.

Family—SCHIZONEURÆÆ.  
Genus—PHYLLOTHECA, Brongniart.

*Phyllothea carnosa*, Ten. Woods.

Loc. Walloon.

*Phyllothea*, sp. ind. (Pl. 42, f. 1.)

Loc. Bundamba.

Family—CALAMITÆÆ.  
Genus—VERTEBRARIA (Royle), McCoy.

*Vertebraria equiseti*, Ten. Woods.

Loc. Tivoli.

Order—FILICES.  
Family—SPHENOPTERIDÆÆ.  
Genus—SPHENOPTERIS, Brongniart.

*Sphenopteris Baileyana*, Ten. Woods.

Loc. Rosewood, near Ipswich.

Genus—TRICHOMANITES, Goeppert.

*Trichomanites larum*, Ten. Woods. ?

Loc. Rosewood, near Ipswich. Occurs also at Burrum

*Trichomanites spinifolia*, Ten. Woods.

Loc. Rosewood, near Ipswich; and Redbank, north of Laidley.

*Trichomanites elongata*, Carruthers, sp.

Loc. Tivoli and Aberdare Mines; and Rosewood, near Ipswich.

Family—NEUROPTERIDÆÆ.  
Genus—THINNFELDIA, Ettingshausen.

*Thinnfeldia odontopteroides*, Morris.

Loc. New Chum, Bundamba; Aberdare; Rosewood Scrub; Pine Mountain; Redbank, north of Laidley; Tivoli; Kilcoy Range.

*Thinnfeldia odontopteroides*, var. *falcata*, Ten. Woods.

Loc. Rosewood, near Ipswich; and Petrie's Quarry, Brisbane.

*Thinnfeldia media*, Ten. Woods.

Loc. Colinton. Occurs also at Burrum.

Family—PECOPTERIDÆ.

Genus—ALETHOPTERIS, Sternberg.

*Alethopteris australis*, Morris.

Loc. Bundamba New Chum; Gray's Seam, Ipswich; Rosewood, near Ipswich; Kilcoy Range; Colinton; Six miles north of Esk; Peak Mountain; and Fassifern. Occurs also at Burrum, and at Stewart's Creek, Rockhampton.

*Alethopteris Lindleyana* (Royle), Feistmantel.

Loc. Redbank, near Mount Esk, north of Laidley.

Family—GLEICHENIACEÆ.

Genus—GLEICHENIA, Smith.

*Gleichenia lineata*, T. Woods.

Loc. Rosewood, near Ipswich.

Family—TENIOPTERIDÆ.

Genus—TENIOPTERIS, Brongniart.

*Teniopteris* (? *Angiopteridium*) *Daintreei*, McCoy.

Loc. Talgai; Rosewood, near Ipswich; Peak Mountain. Occurs also at Stewart's Creek, Rockhampton.

*Teniopteris* (? *Angiopteridium*) *Carruthersi*, T. Woods.

Loc. Redbank, North of Laidley. Also at Stewart's Creek, Rockhampton?

Genus—ANGIOPTERIDIUM, Schimper.

*Angiopteridium*, sp. ind.

Loc. Rosewood, near Ipswich.

Genus—MACROTENIOPTERIS, Schimper.

*Macroteniopteris wyanamatta*, Feistmantel.

Loc. Ipswich.

Genus—SAGENOPTERIS, Presl.

*Sagenopteris rhoifolia* (Presl), Feistmantel.

Loc. Talgai, Darling Downs.

*Sagenopteris cuneata*, Carr., sp.

Loc. Tivoli Coal Mine, Ipswich.

Family—DICTYOPTERIDÆ.

Genus—PHLEBOPTERIS, Brongniart.

*Phlebopteris alethopteroides*, Eth. fil.

Loc. Darling Downs, near Toowoomba.

Section—PHANEROGAMIA.

Class—DICOTYLEDONES.

Order—CYCADACEÆ.

Family—ZAMIÆ.

Genus—PODOZAMITES, F. Braun.

*Podozamites lanceolatus*, Lindley and Hutton.

Loc. Ipswich Basin.

*Podozamites* sp. (Pl. 18, f. 5).

Loc. Redbank, north of Laidley. A somewhat similar plant (Pl. 18, f. 4) occurs at Burrum.

Genus—*PTEROPHYLLUM*, Brongniart.

*Pterophyllum abnorme*, Eth. fl.

Loc. Redbank, north of Laidley.

*Pterophyllum*, *sp. ind.* (Pl. 16, f. 3).

Loc. Colinton.

Genus—*OTOZAMITES*, F. Braun.

*Otozamites Mandeslohi*, Kurt.

Loc. Talgai.

Order—*CONIFERÆ*.

Family—*TAXACEÆ*.

Genus—*TAXITES*, Brongniart.

*Taxites medius*, Ten. Woods.

Loc. Ipswich.

Genus—*CUNNINGHAMITES*, Sternberg.

*Cunninghamites australis*, Ten. Woods.

Loc. Rosewood, near Ipswich.

Genus—*BRACHYPHYLLUM*, Brongniart.

*Brachyphyllum crassum*, Ten. Woods.

Loc. Tivoli; Rosewood, near Ipswich; Clifton.

PLANTÆ INCERTÆ SEDIS.

Genus—*CARDIOCARPUM*, Brongniart.

*Cardiocarpum australe*, Carruthers.

Loc. Tivoli.

Kingdom—*ANIMALIA*.

Sub-Kingdom—*ARTHROPODA*.

Class—*CRUSTACEA*.

Order—*PHYLLOPODA*.

Family—*LIMNADIDÆ*.

Genus—*ESTHERIA*.

*Estheria mangalensis*, Jones.

Loc. Denmark Hill, Ipswich.

Class—*INSECTA*.

Order—*COLEOPTERA*.

Family—*BUPRESTIDÆ*.

Genus—*MESOSTIGMODERA*, Etheridge fl. and Olliff.

*Mesostigmodera typica*, E. and O.

Loc. Denmark Hill, Ipswich.

Sub-Kingdom—*MOLLUSCA*.

Section—*MOLLUSCA VERA*.

Class—*PELECYPODA*.

Order—*UNIONACEÆ*.

Family—*UNIONIDÆ*.

Genus—*UNIO*, Philipsson.

*Unio ipswiciensis*, Eth. fl., Pl. 42, figs. 2 and 3.

Loc. Bremer Basin Colliery.

*Unio eyrensis*, Tate?

Loc. Bundanba.

## SYNOPSIS.

Also in Stewart's Creek Beds and Burrum Beds.	Also in Stewart's Creek Beds.	Also in Burrum Beds.	Occurring in Ipswich Beds.
x	x		<i>Equisetum rotiferum</i> , Ten. Woods. " ? <i>latum</i> , Ten. Woods. <i>Phyllothea carnosus</i> , Ten. Woods. " <i>sp. ind.</i> <i>Vertebraria equiseti</i> , Ten. Woods. <i>Sphenopteris Baileyana</i> , Ten. Woods. <i>Trichomanites laxum</i> , Ten. Woods ? " <i>spinifolia</i> , Ten. Woods. " <i>elongata</i> , Carr. <i>Thinnfeldia odontopteroides</i> , Morris. " " var. <i>falcata</i> , Ten. Woods. " <i>media</i> , Ten. Woods.
	x x	x	<i>Alethopteris australis</i> , Morris. " <i>Lindleyana</i> (Royle), Feist. <i>Gleichenia lineata</i> , Ten. Woods <i>Taniopteris</i> (? <i>Angiopteridium</i> ) <i>Daintreei</i> , McGoy. " <i>Carruthersi</i> , Ten. Woods. <i>Angiopteridium</i> , <i>sp. ind.</i> <i>Phyllopteris Feistmanteli</i> , Eth. fil. <i>Macrotaniopteris wyanamattæ</i> , Feist. <i>Sagenopteris rhoifolia</i> (Presl) Feist. <i>Sagenopteris</i> ? <i>cuneata</i> , Carr., sp. <i>Pneopteris alethopteroides</i> , Eth. fil. <i>Podozamites lanceolatus</i> , L. and H. " <i>sp. ind.</i> (Pl. 18, f. 5). <i>Pterophyllum abnorme</i> , Eth. fil. " <i>sp. ind.</i> (Pl. 16, f. 3). <i>Olozamites Mandeslohi</i> , Kurr. <i>Taxites medius</i> , Ten. Woods. <i>Cunninghamites australis</i> , Ten. Woods. <i>Brachyphyllum crassum</i> , Ten. Woods. <i>Cardiocarpum</i> ? <i>australe</i> , Carr. <i>Estheria mangalensis</i> , Jones. <i>Mesostigmodera typica</i> , Eth. fil. <i>Unio ipswichensis</i> , Eth. fil. " <i>eyrensis</i> , Tate.

Of the thirty-five species above named, three are common to the Stewart's Creek (Rockhampton) Beds; two to the Burrum Beds; and two to both the Stewart's Creek and Burrum Beds.

J.

## CHAPTER XXVIII.

### THE TRIAS-JURA SYSTEM—*continued*.

#### THE IPSWICH FORMATION (UPPER TRIAS-JURA), OUTSIDE OF THE TYPE DISTRICT.

INCLUDING STEWART'S CREEK (ROCKHAMPTON), AND ROSEWOOD AND WYCARBAH (ROCKHAMPTON) BEDS.

A VERY remarkable deposit occurs between the Central Railway at Stanwell and Mount Lyon. A vast series of bedded basaltic rocks is here met with, having a slight general dip to the north. Between, and beneath the beds of basalt, dark carbonaceous shales, thin seams of impure coal, and beds of sandstone occasionally crop out. One bed of ferruginous sandstone, near Mr. Lawrence's Homestead on Stewart's Creek,\* to which I was guided by Captain Christoe in 1885, is full of well-preserved plant-remains.

At Wycarbah Railway Station, twenty-four miles from Rockhampton, a hard fine-grained volcanic tuff is associated with the basaltic rocks. This tuff contains numerous fern-impressions. The late Rev. J. E. Tenison Woods referred to the fossils of this deposit † "as being of great interest, showing a relation with certain Mesozoic plant-beds of India, which have never hitherto been identified outside that country."

In his "Fossil Flora" the same Author referred (pp. 20, 45, 113, and 125) to plant-beds at Rosewood, West of Rockhampton,‡ containing *Ptilophyllum oligoneurum*, Ten. Woods, *Vertebraria towarrensis*, Ten. Woods, *Sequoiites (?) australis*, Ten. Woods, *Pecopteris*, and *Equisetum*.

In my "Handbook of Queensland Geology" (1885), I fell into a mistake in understanding Mr. Tenison Woods to refer, in his Report to the Minister for Lands, certain stratified deposits met with in the first twenty miles of the railway west of Rockhampton (or more correctly from six to twenty miles), "containing-marine shells of well-known species found in the Lower Carboniferous rocks of Europe," to the same deposit as the Stewart's Creek (Rockhampton) Beds. In the same "Handbook" I quoted *Glossopteris* as occurring in the Stewart's Creek Beds; but the fossil in question, having since been submitted to my Colleague, was pronounced to be not *Glossopteris*, but a species of *Phyllopteris*.

Considerable collections of plants have, since 1885, been made by the late Mr. James Smith and myself from the Stewart's Creek, Rosewood, and Wycarbah beds. There seems to be no reason why all the Mesozoic deposits within this limited district should not be massed together and treated as a whole; and, in consideration of the great similarity of their organic remains, I refer them to the Ipswich Formation, although I was at one time strongly inclined to regard the Stewart's Creek, &c. (Rockhampton) Beds, as occupying a lower horizon than the Ipswich Beds, and as, in fact, bridging over at least a part of the gap between the latter and the Burrum Coal Measures.

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\* Not to be confounded with Stewart's Creek, Townsville, where Permo-Carboniferous rocks occur.

† In a Report to the Minister for Lands, dated 7th August, 1883, published in the *Queenslander News-paper*.

‡ Not to be confounded with Rosewood, near Ipswich.

The following is a List of the Flora of the Stewart's Creek (Rockhampton) Beds, as determined or accepted by my Colleague :—

Kingdom—PLANTÆ.

Section—CRYPTOGAMIA.

Class—ACOTYLEDONES.

Order—CALAMARIEÆ.

Family—EQUISETACEÆ.

Genus—EQUISETUM, Linnæus.

*Equisetum rotiferum*, Ten. Woods.

Loc. Stewart's Creek, Rockhampton. Occurs also in the Ipswich Coal Field.

*Equisetum ? latum*, Ten. Woods.

Loc. Rosewood, near Rockhampton.

Family—CALAMITEÆ.

Genus—VERTEBRARIA (Royle), McCoy.

*Vertebraria towarrensis*, Ten. Woods.

Loc. Rosewood, near Rockhampton.

Family—PECOPTERIDÆ.

Genus—ALETHOPTERIS, Sternberg.

*Alethopteris australis*, Morris.

Loc. Stewart's Creek, near Rockhampton. Occurs also in the Ipswich Coal Field and Burrum Coal Field.

Family—TENIOPTERIDÆ.

Genus—TENIOPTERIS, Brongniart.

*Teniopteris* (? *Angiopteridium*) *Carruthersi*, Ten. Woods.

*Teniopteris* (! *Angiopteridium*) *Daintreei*, McCoy.

Loc. Stewart's Creek, Rockhampton. Occurs also in the Ipswich Formation.

Genus—PHYLLOPTERIS, Saporta.

*Phyllopteris Feistmanteli*, Eth. fil.

Loc. Stewart's Creek, Rockhampton. Occurs also in the Styx Coal Field.

Genus—MACROTENIOPTERIS, Schimper.

*Macroteniopteris crassinervis*, Feistmantel. ?

Loc. Wycarbah, near Rockhampton.

Section—PHANEROGAMIA.

Class—DICOTYLEDONES.

Order—CYCADACEÆ.

Family—ZAMIÆ.

Genus—PTILOPHYLLUM, Morris.

*Ptilophyllum oligoneurum*, Ten. Woods.

Loc. Rosewood and Wycarbah, near Rockhampton.

Order—CONIFERÆ.

Family—ARAUCARIÆ.

Genus—ARAUCARITES, Sternberg.

*Araucarites ? polycarpa*, Ten. Woods.

Loc. Stewart's Creek, Rockhampton.

Family—TAXODIACEÆ.

Genus—SEQUIOITES, Carruthers.

*Sequoiites ? australis*, Ten. Woods.

Loc. Rosewood, near Rockhampton.

PLANTÆ INCERTÆ SEDIS.

Genus—CYCADINOCARPUS, Schimper.

*Cycadinocarpus ?* sp. ind.

Loc. Wycarbah.



Quite recently a discovery of coal, which must assume considerable importance when railway communication has been established, was accidentally made by a party of prospectors subsidised by the Government (Messrs. Petersen, Otty, and Dunn), when sinking a shaft in search of alluvial gold. The locality is about fifty-two miles south-west of Gladstone, and about three miles north-west of the Old Callide Station, on Callide Creek. A Report\* by Mr. W. H. Rands, just issued, enables me to give an account of this Coalfield.

The lowest beds of the Coal Measures rest unconformably on Palæozoic rocks, which Mr. Rands says may be Permo-Carboniferous (? Gympie Series). They consist of conglomerates, sandstones, and shales, forming an escarpment of two hundred feet in height, and dip at  $19^{\circ}$  to S.  $27^{\circ}$  W. These strata are overlaid by a bed of close-grained olivine-basalt, which dips in the same direction, but at a lower angle. The stratified rocks re-emerge from beneath this lava-flow, at a lower elevation, further to the west, but are covered on the higher ridges with patches of basalt. Regarding the age of the coal-bearing strata, Mr. Rands says:—

"I found two varieties of plant-remains in a thin bed of indurated clay in the gully near Shaft No. 3. One of these closely resembles the description given by Professor Ottokar Feistmantel† of *Thinnfeldia odontopteroides*, Morris, except that the pinnules appear to be divided at the base, instead of being "connate." This fossil is found in both the Hawkesbury and in the Wianamatta Series, New South Wales; and in the Upper Mesozoic Beds of Ipswich. This form is very numerous here. The other is a species of *Tæniopteris*, in which the veins are parallel, and about one-thirteenth of an inch apart. These remains would point to the beds belonging to the Upper Mesozoic, and probably they are the same age as the Ipswich Beds."

The following remarks are taken from Mr. Rands' description of the coal-seams:—

"Shaft No. 1.—The top eight feet is timbered, but I understand that it consisted of a black carbonaceous shale or clod.

	Ft.	in.
Timbered ... ..	8	0
Coal (with a 1-inch band of clay at $6\frac{1}{2}$ feet from the top, and a $\frac{1}{2}$ -inch band at 7 feet from the top ... ..	10	5
Greyish brown sandstone, thinning out to a mere streak on one side of the shaft... ..	0	8
Coal (three feet of this were under water) ... ..	7	0
Hard carbonaceous sandstone; thickness unknown.		

"The top ten feet of coal is of a somewhat friable character, but the bottom seven feet is a good strong coal. Analyses of this coal are given below, and from the analyses and appearance it should make a good steam coal. The beds just here are nearly horizontal.

"Shaft No. 2.—The shaft was partially filled with water, so that I was unable to descend. They are reported to have passed through in sinking—

	Ft.	in.
Greyish sandstone ... ..	8	0
Black carbonaceous shale or clod ... ..	5	0
Coal, not bottomed ... ..	12	0

"The large heap of coal on the surface is a bright, clean coal. An analysis of the coal is given below. The coal from this shaft appeared to consist to a great extent of *Sporangia*. I cut a thin section for the microscope, and found it to be full of small circular spores, which appear brown in the almost opaque coal. I believe these to be *Sporangia*, but I found great difficulty in getting the section fully transparent.

\* New Discovery of Coal near the Callide Creek, Port Curtis District. Brisbane: by Authority: 1891.

† Geol. Pal. Relations Coal and Plant-bearing Beds of E. Australia. *Mém. Geol. Survey N. S. Wales*, Pal. No. 3, p. 101.

"No. 3 Shaft.—There were four feet of water in the bottom of the shaft, but I was able to descend and examine it down to that depth. The shaft passed through—

	Ft.	in.
Grey sandstone ... ..	30	0
Brown shales and clay ... ..		
Black carbonaceous shale or clod ... ..		
Coal (twenty-six feet of this was above the water) ... ..	30	0

"I could discover no bands in the twenty-six feet of coal visible. It is a clean coal. The beds dip slightly north-east.

"Shaft No. 6 is forty feet, but it was nearly full of water. I was informed by the prospectors that the coal in this shaft was twenty-four feet thick, with a thin band at about eleven feet from the top of the seam. The following section was given to me as approximately correct:—

	Ft.	in.
Sandstone and black carbonaceous shale ... ..	16	0
Coal ... ..	11	0
Band ... ..	0	3
Coal ... ..	13	0

"No coal has been seen actually cropping out at the surface.

"The following are Approximate Analyses of the coals made for me by Mr. W. A. Dixon, F.I.C., F.C.S., of the Technical College, Sydney:—

	SHAFT No. 1.		Shaft No. 2.	Shaft No. 3.
	Top portion of the seam.	Bottom portion of the seam.		
Moisture ... ..	8.35	8.40	9.15	9.95
Volatile hydrocarbons ... ..	28.79	24.49	26.71	23.63
Fixed carbon ... ..	41.74	57.36	51.24	54.20
Ash ... ..	20.78	9.50	12.62	12.04
Sulphur ... ..	0.34	0.25	0.28	0.18
	100.00	100.00	100.00	100.00

"Mr. Dixon adds: 'None of the samples yield any true coke. The ash is in each of them perfectly white and rather gritty. The sample from Shaft No. 1, top portion of the seam, is rather tender, whilst the others are strong, and have the appearance of splint coal, but the analysis shows that they belong rather to the class of lignite than true coal.'

"The following Analysis was made by Mr. J. Cosmo Newbery, for Mr. Spiers, of Rockhampton. The sample was from Shaft No. 1, but I do not know which portion of the seam it is from. The analysis is, like that of Mr. Dixon's, from the bottom portion of the seam, but it contains less ash:—

Moisture ... ..	9.510
Volatile hydrocarbons ... ..	26.365
Fixed carbon ... ..	59.850
Ash ... ..	4.275
	100.000

"The coal is non-coking, and gives a light white ash.

"The analysis would point to the coal being a good steam coal, though the calorimetric power of the coal requires testing.

"The sample from the top portion of the seam from Shaft No. 1 gave so high a percentage of ash that I determined to try another sample, with the result that I obtained 4.6 as a percentage of ash. It is very probable, therefore, that the sample sent to Mr. Dixon for analysis had a small impure coaly band in it."

## CHAPTER XXIX.

### THE TRIAS-JURA SYSTEM—*continued.*

#### THE IPSWICH FORMATION (UPPER TRIAS-JURA); ITS AGE AND RELATIONS.

IN his Paper "On the Geology of Queensland," read in 1872 before the Geological Society of London,\* the late Mr. Richard Daintree insisted on the importance of the two ferns *Glossopteris* and *Tæniopteris* as characteristic, the former of the Palæozoic, and the latter of the Mesozoic Coal Deposits. The late Rev. Julian E. Tenison Woods, in his "Fossil Flora of the Coal Deposits of Australia" (p.11), remarked that "the selection of *Tæniopteris* is unfortunate, because it is not common,† and probably included distinct genera, according to the classification then adopted. *Thinnfeldia* is a much better typical fossil of the Mesozoic Beds, and it is never found associated with *Glossopteris*. It is very common and prevails everywhere in Oolitic plant-beds."‡ On the ground that *Tæniopteris* was common to them all, Mr. Daintree regarded the Ipswich Coal Formation as the equivalent of "the *Tæniopteris* Coal Measures of Victoria and of the Richmond River, N.S.W." To Daintree Mr. Tenison Woods (*loc. cit.*) assigns "the credit of co-relating the Jerusalem (Tasmanian) Beds with those of Ipswich," but I cannot find any warrant for this in Daintree's Paper itself.

Mr. Tenison Woods, at one time,§ classed the Ipswich Coal Measures as Jurassic, and placed the Desert Sandstone on the same horizon. This view as to the position of the Desert Sandstone never was entertained by any other Geologist, and is obviously incorrect, when it is considered that that formation actually overlies unconformably the Rolling Downs Formation, which is itself newer than the Ipswich Formation. It was abandoned by Mr. Tenison Woods himself in his latest account of the Desert Sandstone|| in favour of an idea not less untenable—viz., that "it [the Desert Sandstone] probably belongs to the two great volcanic periods of Tertiary age."

Mr. Woods further placed on the same horizon as the Ipswich Beds the Clarence River Beds, and the Hawkesbury Sandstone of New South Wales. The Ipswich Beds cross the border into New South Wales, where they are known as the "Clarence Series." The latter contains, according to the late Mr Charles S. Wilkinson, Government Geologist of New South Wales, no *Glossopteris*, but *Tæniopteris Daintreei*, *Alethopteris australis*, and *Thinnfeldia*, and may be newer than the Wianamatta Beds, and of the same age (Jurassic) as the Victorian Coal Series of which *Tæniopteris Daintreei* is a characteristic fossil.¶ Mr. Wilkinson's observations\*\* may be quoted to show the distinction between the Hawkesbury and Wianamatta Beds.

"The surface of the Hawkesbury formation was denuded and worn into hollows before the Wianamatta beds were deposited; and the latter in their lithological

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\* Quart. Journ. Geol. Soc., 1872, Vol. xxviii., p. 288.

† Several sections of *Tæniopteris* are very common indeed in many localities within the "Ipswich" and Stewart's Creek (Rockhampton) areas. (*R.E. Junr.*)

‡ The value of *Tæniopteris*, using the genus in the widest acceptance of the term, as marking the presence of Mesozoic Beds as against those of Permo-Carboniferous age, holds now as good as when Mr. Daintree wrote. In Queensland *Tæniopteris* has not yet been found lower than the Burrum (Styx) Coal Measures. (*R.E. Junr.*)

§ Flora, pp. 18 and 19.

|| Journ. R. Soc. N. S. Wales, 1888, xxii., p. 290.

¶ Notes on the Geology of New South Wales, 1882, p. 55.

\*\* *Loc. cit.*, p. 54.

character also show that great physical changes must have taken place, for they consist chiefly of argillaceous shales, which are in striking contrast with the thick-bedded arenaceous rocks underlying them. The fine sediment which formed the Wiannamatta shales evidently settled down in the quiet waters of a lake."

Both the Hawkesbury and the Wianamatta Beds contain plants which are common in the Ipswich Formation and in the Clarence Beds, and both contain, in addition, remarkable deposits of fish remains,\* of which the Ipswich and Clarence Beds have, so far as I am aware, as yet furnished no equivalent.

As for the last two years the Stratigraphy and Palæontology of the Mesozoic rocks of New South Wales have been closely studied by the late Mr. C. S. Wilkinson, Mr. (now Professor) T. W. Edgeworth David, and my Colleague, we are enabled to give the latest views of the Geological Survey in the following concise table † :—

Thickness. Feet.	
Triassic	Tæniopteris beds of Talbragar River, and part of the Clarence District.
	700. Wianamatta Shales, with <i>Macrotæniopteris</i> , <i>Thinnfeldia</i> , &c.
	1,000. Hawkesbury Sandstone, with <i>Thinnfeldia</i> , <i>Palæoniscus</i> , <i>Platiceps Wilkinsoni</i> , &c.
	9 Ballimore Beds.
	800. Narrabeen Shales, with <i>Thinnfeldia</i> , and <i>Estheria</i> and intercalated cupriferous tuffs.

In Victoria, Mr. Reginald A. F. Murray, following Mr. Wilkinson, accepts ‡ the Carbonaceous (? Oolitic) rocks of the Wannon, Cape Otway, Western Port, and South Gippsland as the equivalent of the Clarence River Beds, and the Bacchus Marsh Sandstones as the equivalent of the Hawkesbury Sandstones, there being no recognised equivalent of the Wianamatta Beds. The "Carbonaceous (? Oolitic) rocks" contain *Zamites* (*Podozamites*) *Barklyi*, McCoy; *Zamites* (*Podozamites*) *ellipticus*, McCoy; *Zamites longifolius*, McCoy; *Tæniopteris Daintreei*, McCoy; and *Alethopteris* (*Pecopteris*) *australis*, Morris, whose nearest European ally is *Pecopteris scarburgensis*, Bean, MS. as determined by Prof. Sir F. McCoy.§

In Tasmania "the rocks of Mesozoic age consist mainly of variegated sandstones, shales, blue and white clays, often of great thickness, and extending throughout the midland, southern, and south-eastern districts. They frequently contain seams of coal, sometimes, as in the Fingal District, of great thickness and of fair quality. The beds of the system are distributed in distinct basins, often greatly disturbed and broken up by intrusive dykes of greenstone, and on this account, and because of the great sameness of plant-remains, there is great difficulty in attempting to break up the beds of the system into subdivisions. The beds probably cover the whole period from the close of the Upper Palæozoic Coal Measures to the beginning of the Tertiary Period. No marine deposits break the sequence, as in Queensland. The great Lignite and Leaf Bed Series (Palæogene) with leaves of oaks, elms, laurels, beech, cinnamon, and other trees, generally overlie the Mesozoic members in the Launceston Tertiary Basin."

The "Upper (Mesozoic) Coal Measures" are developed at Derwent, Jerusalem, Fingal, Longford, Hamilton, Spring Bay, Port Cygnet Basins, &c. An "Older Sand-

\* See Memoirs of the Geological Survey of New South Wales, Pal., No. 4. "The Fossil Fishes of the Hawkesbury Series at Gosford." By Arthur Smith Woodward, F.Z.S., F.G.S. Sydney: by Authority: 1890.

† A Correlation of the Coalfields of New South Wales. By T. W. E. David, B.A., F.G.S. *Proc. Austr. Assoc. Adv. Sci.*, Vol. ii., 1890, p. 464.

‡ Geology and Physical Geography of Victoria. Melbourne: by Authority: 1887.

§ Prodromus of the Palæontology of Victoria, Decade i., 1874, and Decade ii., 1875.

stone Formation," consisting of "reddish or yellow micaceous sandstones, sometimes of great thickness, often occurs overlying the uppermost beds of the Upper Palæozoic mudstones, as at Tinder Box Bay, Huon Road, and Waterworks Valley, near Hobart, with indistinct plant-impressions and silicified trunks of conifers. These sandstones apparently lie conformably, and without stratigraphic break, upon the uppermost beds of the Upper Marine series. Their position is assigned, provisionally, at the base of the Mesozoic group of rocks of Tasmania."\*

The majority of the plants characteristic of the Ipswich Formation are met with, according to Mr. Johnston's lists, in the Upper Coal Measures of Tasmania, and many others besides. It must be pointed out that Mr. Johnston obtained from the same locality (Lord's Hill, Newtown) *Glossopteris* (*G. moribunda*, Johnston) and *Tæniopteris* (*T. tasmanica*, Johnston).†

If the Tasmanian Mesozoic Beds, as Mr. Johnston supposes, cover, without a break, "the whole period from the close of the Upper Palæozoic coal measures to the beginning of the Tertiary period," the Ipswich Formation can only represent a small portion of the same time, as between the Ipswich Beds and the Tertiary, the whole period represented by the Rolling Downs and Desert Sandstone, and the unconformability between them, must intervene—and that was certainly of no insignificant duration.

In New Zealand "The most valuable coal deposits occur in the Cretaceous-tertiary formation—but always beneath such of the marine beds of the formation as are present in the locality where the coal occurs. The coal-bearing beds always rest upon the basement rock of the district [slates and granites] marking a great unconformity and the closing of a long-persistent land area at the period to which they belong."‡ It is evident that this Coal Field can have nothing in common, so far as its age is concerned, with the Ipswich Coal Field.

Older than the Cretaceous-Tertiary Coal Fields are the Buller Series, consisting of conglomerate and sandstones, with coal-seams, and the Amuri Series, consisting of green and grey incoherent sandstones, with hard concretions and large masses of silicified wood. "This formation, which is confined to a few localities of limited extent, is very rich in fossils of the genera *Belemnites* and *Trigonia*, with a few saurian bones and teeth of large chimaeroid fishes."§ The Buller and Amuri Series are classed by the Geological Survey of New Zealand as Lower Greensand.

Next in order come the Matura, Putataka, and Flag Hill Series, classed by the Geological Survey as Jurassic. The Matura series "consists largely of estuarine beds, marine fossils being absent or rare. It consists of dark-coloured marls and fine-grained sandstones, and contains the fossil remains of a number of plants, of which eight species have been recognised. Amongst these are *Camptopteris*, *Cycadites*, and *Echinostrobus*, which connect them with the plant-beds of the next lower formation. Those found at Waikawa and Matura Falls are especially interesting, from at least one species, *Macrotæniopteris lata*, being identical with a plant found in the Rajmahal beds of India, which are considered to be of Liassic age. . . . The Matura series, overlying the Putataka series, closes the old secondary sequence at Kawhia, in the Auckland District, and the same plants are found in the Clent Hills plant-beds, and from the natural sections,

\* Systematic Account of the Geology of Tasmania, p. 149. By Robt. M. Johnston, F.L.S., &c. Hobart: by Authority: 1888.

† *Op. cit.*, p. 177.

‡ Catalogue and Guide to the Geological Exhibits, New Zealand Court, Indian and Colonial Exhibition, p. 59. By Sir James Hector, Director of the Geological Survey. Wellington: by Authority: 1886.

§ *Op. cit.*, p. 63.

and also from the very characteristic forms below them, there can be no doubt that they should be referred to the Upper Oolite period. . . . The Putataka beds are of marine origin, and contain Middle Oolite fossils." The Flag Hill series is marine.\*

It may be conjectured that the Mataura Beds represent at least some portion of the Ipswich Formation, but the preponderance of marine beds in the Mesozoic Trias of New Zealand presents a striking contrast to Tasmania.

Of the whole Queensland Mesozoic System, between the uppermost fresh-water Coal Measures of the Bowen River Coal Field (Permo-Carboniferous), and the Rolling Downs Formation (Cretaceous), *i.e.*, the Burrum, Stewart's Creek (Rockhampton), and Ipswich Beds, my Colleague says that the organic remains are principally those of plants, with a strong Mesozoic facies, and oscillating in all probability between the Trias and Upper Oolite in age. Since he expressed the above opinion, however, my Colleague has, together with Professor Edgeworth David, attributed a Triassic age to some of the New South Wales equivalents of the Ipswich (and Burrum?) Formations. As the Mesozoic Formations have been more closely studied in New South Wales, it will be well to extend the range of the Queensland (Burrum and Ipswich) downward to the base of the Trias. As, on the other hand, the Ipswich Formation appears to graduate upwards, without break, into the Cretaceous of the Rolling Downs, it is probable that the Queensland strata cover the whole of the time between the base of the Trias and the top of the Oolite. It thus becomes convenient to classify the Burrum and Ipswich Formations respectively as Lower and Upper Trias-Jura.

It is possible that in the sandstones of Murphy's Creek and other localities on the slopes of the Toowoomba Range, we may have the equivalents of the Hawkesbury Sandstones.

The following is my Colleague's List of the Fossils from the whole of the Queensland strata which are grouped together under the name of the Ipswich Formation:—

Kingdom—PLANTE.	Family—NEUROPTERIDÆ.
Section—CRYPTOGAMIA.	Genus—THINNFELDIA.
Class—ACOTYLEDONES.	<i>Thinnfeldia odontopteroides</i> , Morris.
Order—CALAMARIÆ.	" Woods. " var. <i>falcata</i> , Ten.
Family—EQUISETACEÆ.	" media, Ten. Woods.
Genus—EQUISETUM.	Family—PECOPTERIDÆ.
<i>Equisetum rotiferum</i> , Ten. Woods.	Genus—ALETHOPTERIS.
" ? <i>latum</i> , Ten. Woods.	<i>Alethopteris australis</i> , Morris.
Family—SCHIZONEURÆÆ.	" <i>Lindleyana</i> , Feist.
Genus—PHYLLOTHECA.	Family—GLEICHENIACEÆ.
<i>Phyllothea carnosæ</i> , Ten. Woods.	Genus—GLEICHENIA.
" <i>sp. ind.</i> , Pl. 42, fig. 1.	<i>Gleichenia lineata</i> , Ten. Woods.
Family—CALAMITÆÆ.	Family—TENIOPTERIDÆ.
Genus—VERTEBRARIA.	Genus—TENIOPTERIS.
<i>Vertebraria equiseti</i> , Ten. Woods.	<i>Taniopteris</i> (? <i>Angiopteridium</i> ) <i>Daintreei</i> , Ten.
" <i>towarrensensis</i> , Ten. Woods.	Woods.
Order—FILICES.	<i>Taniopteris</i> (? <i>Angiopteridium</i> ), Carr.
Family—SPHENOPTERIDÆ.	Genus—ANGIOPTERIDIUM.
Genus—SPHENOPTERIS.	<i>Angiopteridium, sp. ind.</i>
<i>Sphenopteris Baileyana</i> , Ten. Woods.	Genus—PHYLLOPTERIS.
Genus—TRICHOMANITES.	<i>Phyllopteris Feistmanteli</i> , Eth. fil.
<i>Trichomanites laxum</i> , Ten. Woods. ?	
" <i>spinifolia</i> , Ten. Woods.	
" <i>elongata</i> , Carr.	

\* *Op. cit.*, pp. 65-68.

Genus—MACROTENIOPTERIS.  
*Macrotaniopteris wianamotta*, Feist.  
 „ *crassinervis*, Feist.  
 „ *sp. ind.*  
 Genus—SAGENOPTERIS.  
*Sagenopteris rhoifolia*, Presl.  
 „ ? *cuneata*, Carr.  
 Family—DICTYOPTERIDE.  
 Genus—PHLEBOPTERIS.  
*Phlebopteris alethopteroides*, Eth. fil.  
 Section—PHANEROGAMIA.  
 Class—DICOTYLEDONES.  
 Order—CYCADACEÆ.  
 Family—ZAMIÆ.  
 Genus—PODOZAMITES.  
*Podozamites lanceolatus*, Lindley and Hutton. ?  
 „ *sp. ind.*  
 Genus—OTOZAMITES.  
*Otozamites Mandeslohi*, Kurr.  
 Genus—PTEROPHYLLUM.  
*Pterophyllum abnorme*, Eth. fil.  
 „ *sp. ind.*, Pl. 16, fig. 3.  
 Genus—PTILOPHYLLUM.  
*Ptilophyllum oligoneurum*, Ten. Woods.  
 Order—CONIFERÆ.  
 Family—ARAUCARIÆ.  
 Genus—ARAUCARITES.  
*Araucarites ? polycarpa*, Ten. Woods.  
 Family—TAXODIACEÆ.  
 Genus—SEQUIOITES.  
*Sequoites ? australis*, Ten. Woods.

Family—TAXACEÆ.  
 Genus—TAXITES.  
*Taxites medius*, Ten. Woods.  
 Genus—BRACHYPHYLLUM.  
*Brachyphyllum crassum*, Ten. Woods.  
 Genus—CUNNINGHAMITES.  
*Cunninghamites australis*, Ten. Woods.  
 PLANTÆ INCERTÆ SEDIS.  
 Genus—CARDIOCARPUM.  
*Cardiocarpum ? australe*, Carr.  
 Kingdom—ANIMALIA.  
 Sub-Kingdom—ARTHROPODA.  
 Class—CRUSTACEA.  
 Order—PHYLLOPODA.  
 Family—LIMNADIDÆ.  
 Genus—ESTHERIA.  
*Estheria mangaliensis*, Jones.  
 Class—INSECTA.  
 Order—COLEOPTERA.  
 Genus—MESOSTIGMODEBA.  
*Mesostigmodera typica*, Eth. fil. and Olliff.  
 Sub-Kingdom—MOLLUSCA.  
 Section—MOLLUSCA VERA.  
 Class—PELECYPODA.  
 Order—UNIONACEÆ.  
 Family—UNIONIDÆ.  
 Genus—UNIO.  
*Unio ipsviciensis*, Eth. fil.  
*Unio eyrensis*, Tate.

In the above list we have five species of plants—viz.: *Trichomanides laxum*, *Thinnfeldia media*, *Teniopteris Daintreei*, *Phyllopteris Feistmanteli*, and *Alethopteris australis*, common to the Burrum beds.

Although, so far as we know, there is no evidence of a break between the Ipswich and Rolling Downs Formation, but, on the contrary, everything points to an uninterrupted succession, the whole of the above copious flora is unrepresented in the Rolling Downs Formation. This circumstance, however, may mean nothing more than a change from terrestrial or lacustrine to marine conditions. Two species (but not the same) of *Unio* occur both in the Ipswich and Rolling Downs Formations.

Again, in spite of the moderately large list of plants and marine organisms furnished by the Desert Sandstone (Upper Cretaceous), the latter has not a single species, or even genus, in common with the Ipswich Formation.

## CHAPTER XXX.

### THE ORGANIC REMAINS OF THE IPSWICH FORMATION

(UPPER TRIAS-JURA),

WITH DESCRIPTIONS OF THE SPECIES.

Kingdom—PLANTÆ.

Section—CRYPTOGAMIA.

CLASS—ACOTYLEDONES.

Order—CALAMARIEÆ.

Family—EQUISETACEÆ.

Genus—*EQUISETUM*, *Linnaeus*, 1778.

(*Gen. Plantarum*, 551.)

*EQUISETUM ROTIFERUM*, *Ten. Woods*.

*Equisetum rotiferum*, *Ten. Woods*, *Proc. Linn. Soc. N. S. Wales*, 1882, vii., Pt. 3, p. 344.

„ „ „ *Ten. Woods, loc. cit.*, 1883, viii., Pt. 1, p. 66, t. 6, f. 5 and 6.

*Sp. Char.* “Stem cylindrical, closely and faintly grooved, joints approximate below, distant above, leaves carinate, conate into a sheath, the teeth of which are short, flat, round, of equal width throughout, adpressed to the stem. The diaphragmata of the joints and leaf-scars of the branches are very distinct, round, with radiate laminae varying from eighteen to thirty, and a central orifice. Fructification unknown.”

*Obs.* The general appearance of the fragmentary remains of this plant is thus given by the *Rev. J. E. T. Woods*. “There are certain disk-like forms of rather an ornamental character. They are shaped like toothed wheels, with a small central perforation, and a radiate ring of pear-shaped perforations near the edge.” The present plant appears to be related to *Equisetum rajmahalensis*,\* the diaphragm in the two species being similar.

In Pl. 16, fig. 9, a phragma of an equisetaceous plant is figured. Although twice the natural size, it will be seen that this is far larger than the specimen figured by the *Rev. J. E. T. Woods*. Until we know more of the fragmentary remains of these Mesozoic plants it would be rash to determine such a specimen. From the same locality as the last plant referred to, a portion of a stem has been obtained. It is an internode of rather more than one inch in length and about seven-sixteenths of an inch broad, and the surface microscopically striate parallel to the longer axis. One of the ends is terminated by a well-marked point of articulation.

*Loc.* Walloon Mine, Ipswich. Grey fireclays above first coal-seam (*The late Rev. J. E. T. Woods*; Macleay Museum, University of Sydney). Stewart's Creek, near Rockhampton (*The late James Smith*).

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\* *Mem. Geol. Survey of India*; *Paleontologia Indica*; *Fossil Flora of the Gondwana System*. Oldham and Feistmantel, Vol. i., Pl. 11, f. 3.



## EQUISETUM? LATUM, Ten. Woods.

*Equisetum? latum*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 87, t. 2, f. 1.

*Sp. Char.* "Broad stems two or three inches wide, with numerous small close ribs."

*Obs.* There are, according to the describer, about twenty ribs to an inch. It is compared to *Equisetum Mougéotti*, Brong., a Trias fossil of the Vosges. The Mining and Geological Museum, Sydney, contains examples of an *Equisetum*, believed to be this species, eight inches in length and two and a half in width, and bearing about the same number of delicate ribs to the inch as mentioned by Mr. Woods. The mean of a number of computations is twenty-three.

*Loc.* Esk Valley, forty-six miles west-north-west of Ipswich (*W. Souttar*; Mining and Geol. Museum, Sydney); Rosewood, near Rockhampton (*The late Rev. J. E. T. Woods*; Macleay Museum, University of Sydney).

## Family—SCHIZONEURÆ.

Genus—*PHYLLOTHECA*, Brongniart, 1828.

(Prod. Hist. Vég. Foss., p. 151.)

*Obs.* *Phyllothea* has been described as a Queensland genus by the late Rev. J. E. T. Woods, but his remarks are somewhat contradictory as to its occurrence. In the early part (p. 18) of his Memoir "On the Fossil Flora of the Coal Deposits of Australia"† he quotes *Phyllothea concinna* as found in the Ipswich Beds, but later (p. 39), when this species is described, its range is confined to the Hawkesbury Sandstone of New South Wales.

Again he says, "For my own part, after a careful search, I have never found any true or characteristic *Phyllothea* in the Ipswich Coal Beds." Then why describe the following species immediately after, as he does, without a note of interrogation after the genus. *Phyllothea* was identified by the Rev. Author from the Cooktown Coal Beds\* (Permo-Carboniferous), but this was abandoned in his larger Memoir.

*PHYLLOTHECA CARNOSEA*, Ten. Woods.

*Phyllothea carnea*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 75, t. 9, f. 2.

*Obs.* This species was named from a faint impression, imperfect, but showing a "close succession of verticillate leaves, which radiate very slightly from the stem. They are close, obtuse, about half a millimetre wide, and five long. They form five cup-shaped divisions on a stem thirty-five millimetres long and ten wide." It is considered by Mr. Woods to be an ally of *P. robusta* of the Indian Lias. The specimens at present in the Macleay Museum are quite unworthy of a name.

*Loc.* Walloon Mine, Ipswich (*The late Rev. J. E. T. Woods*; Macleay Museum, University of Sydney).

*PHYLLOTHECA*, *sp. ind.*, Pl. 42, fig. 1.

*Obs.* A few small whorls of lanceolate leaves have presented themselves from Bundanba. There are fourteen in a circle, the largest measuring eight millimetres, and the opening left by the decay of the stem measuring two millimetres. The leaves are short and lanceolate, and their bases appear to be sessile or decurrent on the

\* Proc. Linn. Soc. N. S. Wales, 1882, vii. p. 95.

† Author's separate copy.

internode. The arrangement is similar to McCoy's figure of *Phyllothea ramosa*,\* but there is even a greater resemblance to Feistmantel's illustration of *P. robusta*† from the Lower Gondwanas.

*Loc.* Borehole Colliery, Bundanba, near Ipswich (*R. C. Ringrose*).

### Family—CALAMITEÆ.

*Genus*—*VERTEBRARIA* (*Royle*), *McCoy*, 1847.

(*Ann. and Mag. Nat. Hist.*, 1847, xx., p. 145.)

*VERTEBRARIA EQUISETI*, *Ten. Woods*.

*Vertebraria equiseti*, *Ten. Woods*, *Proc. Linn. Soc. N. S. Wales*, 1883, viii., Pt. 1, p. 80, t. 1, f. 3.

*Sp. Char.* Roots found in broad, finely striated masses, three or four inches long, with occasional transverse divisions half an inch or so across. (*Ten. Woods*.)

*Obs.* Mr. Woods states that three different kinds of roots can be distinguished.

"A broad striated stem, half an inch in diameter, with transverse divisions at irregular intervals."

"A narrow cylindrical stem with parallel striations, and no diaphragmata."

"Stems with a central longitudinal division and irregular transverse diaphragmata, which occasionally correspond at each side of the longitudinal line and occasionally do not."

These bodies are believed to be the rhizomes of *Equisetum rotiferum*.

*Loc.* The Author says, "I shall distinguish the *Vertebraria* common in the blue clay at the Walloon Mines as *V. equiseti*." Further on he adds, "Found in grey clay below the coal in the Tivoli Mine." The latter locality is confirmed by my Colleague.‡

*VERTEBRARIA TOWARRENSIS*, *Ten. Woods*.

*Vertebraria Towarrensii*, *Ten. Woods*, *Proc. Linn. Soc. N.S. Wales*, 1883, viii., Pt. 1, p. 81, t. 1, f. 1, 2, and 4.

*Sp. Char.* Broad stems with deep or regular longitudinal grooves, but with slight transverse divisions, which are irregular, at long distances apart, or absent. (*Ten. Woods*.)

*Obs.* The parallel lines are described as regular in some specimens, in others they curve, twist, and fold over one another. There is a general resemblance between these fossils and *Vertebraria*, but they are very dubious-looking plant-remains.

*Loc.* Rosewood, twenty four miles west of Rockhampton (*The late Rev. J. E. T. Woods*; Macleay Museum, University of Sydney).

### Order—FILICES.

#### Family—SPHENOPTERIDÆ.

*Genus*—*SPHENOPTERIS*, *Brongniart*, 1828.

(*Prod. Hist. Vég. Foss.*, p. 50.)

*SPHENOPTERIS BAILEYANA*, *Ten. Woods*.

*Sphenopteris (Hymenophyllum) Baileyana*, *Ten. Woods*, *Proc. Linn. Soc. N. S. Wales*, 1883, viii., Pt. i., p. 93, t. 4, f. 2.

*Sp. Char.* Frond bi-pinnatifid, membranaceous; rachis winged; pinnules alternate almost simple, broad at the base, becoming regularly narrower at each lobe, so as

\* *Ann. and Mag. Nat. Hist.*, 1847, xx., t. 11, f. 2.

† *Pal. Indica (Gondwana Flora)*, 1879, Ser. xii., No. 1, t. 14a, *lis.*, f. 1, 1a, and 2. }

‡ *Handbook Queensland Geol.*, p. 63.

to form an almost conical leaflet, emerging at an open angle and curving upward, the lower shorter, the upper longer and spreading; lobes linear, narrow, rounded, very slightly segmented, much longer in the upper pinnules, the terminal lobe produced; costa conspicuous, reaching the apex; veins very fine, emerging at an acute angle, bifurcating immediately, sending a venule to the end of each lobe. (*Ten. Woods.*)

*Obs.* This fern is said to be comparable with the genus *Hymenophyllum*, but the figure is so frightfully obscure that it becomes difficult to make anything of it.

*Loc.* Rosewood, near Ipswich (*The late Rev. J. E. T. Woods*; Macleay Museum, University of Sydney).

*Genus*—*TRICHOMANITES*, Goepfert, 1836.

(*Syst. Fil. Foss.*, p. 174.)

*TRICHOMANITES LAXUM*, *Ten. Woods*, ? Pl. 18, fig. 9.

*Trichomanides laxum*, *Ten. Woods*, *Proc. R. Soc. N. S. Wales*, 1883, viii., Pt. 1, p. 95, t. 10, f. 2.

*Loc.* Rosewood, near Ipswich (*The late Rev. J. E. Tenison Woods*; Macleay Museum, University of Sydney).

Occurs also in the Burrum Coal Field, under which head a description will be found.

*TRICHOMANITES SPINIFOLIA*, *Ten. Woods*, Pl. 18, fig. 8.

*Trichomanides spinifolia*, *Ten. Woods*, *Proc. Linn. Soc. N. S. Wales*, 1883, viii., Pt. 1, p. 95, t. 3, f. 7.

*Sp. Char.* Frond somewhat stiff, spreading, dichotomously divided, bi-pinnate, pinnae opposite, or nearly so, long, linear, and, together with the rachis, membranaceously winged; pinnules nearly opposite or alternate, very short and quite acute, the apical one long and linear, veins thick, simple, free. (*Ten. Woods.*)

*Obs.* This fern is distinguished by its rigid aspect, numerous close pinnae, and short and acute pinnules, except the terminal one, which is disproportionately linear. (*Ten. Woods.*)

The specimens before me, of which Pl. 18, fig. 8, may be taken as a good example, are larger and stronger, and the pinnules more spine-like, blunt, and rigid. They appear to form a link between this species and *T. elongata*, Carr., sp. Again, there is a resemblance between the present plants and *Hymenophyllites dubia*, Curran.\*

*Loc.* Rosewood, near Ipswich (*The late Rev. J. E. T. Woods*; Macleay Museum, University of Sydney); Redbank, near Mount Esk, Brisbane River, north of Laidley (*W. Souttar*)—Hard, altered, brittle shale.

*TRICHOMANITES ELONGATA*, *Carruthers*, sp.

*Sphenopteris elongata*, *Carruthers*, *Quart. Journ. Geol. Soc.*, 1872, xxviii., p. 355, t. 27, f. 1.

" " *Ten. Woods*, *Proc. Linn. Soc. N. S. Wales*, 1883, viii., Pt. 1, p. 92.

" " *Feistmantel*, *Palaeontographica*, 1878, Suppl., Bd. iii., Lief 3, Heft 3, p. 108.

*Sp. Char.* Frond dichotomously divided, each division irregularly pinnate; pinnae simple, bifurcate, or irregularly pinnate; segments narrow, linear, slightly tapering upwards to the rather blunt apex; the single midrib sending out simple branches, which run along the middle of each segment. (*Carruthers.*)

*Obs.* This species is said by Mr. Carruthers to be an abundant fern, but the *Rev. J. E. T. Woods* casts some doubt on this statement. The fern seems to accord much more with *Trichomanites* than it does with *Sphenopteris*.

\* *Proc. Linn. Soc. N. S. Wales*, 1884, ix., Pt. 2, p. 253, t. 9, f. 1 and 2.

*T. elongata* would appear to be a less rigid and more laxly growing fern than *T. spinifolia*, Woods. The spiniform pinnules are also absent, but specimens conform much more to Woods' description of the terminal pinnules of his species. A stouter and more rigid-looking variety has been collected by Mr. G. Sweet, at Thomas's Mine. The midrib is also less distinct and the pinnules are striate.

*Loc.* Tivoli Coal Mine, Ipswich (*The late R. Daintree*); the same and Thomas's Aberdare Coal Mine, Ipswich (*The late Rev. J. E. T. Woods*—Macleay Museum, University of Sydney; *G. Sweet*—Colln. Sweet, Melbourne).

### Family—NEUROPTERIDÆ.

*Genus*—*THINNFELDIA*, *Ettingshausen*, 1852.

(Abhandl. K. K. Geol. Reichsanstalt, i., Abth. 3, No. 3, p. 2.)

*THINNFELDIA ODONTOPTEROIDES*, *Morris*, sp., Pl. 17, f. 1, and ? Pl. 17, f. 7.

*Pecopteris odontopteroides*, *Morris*, *Strzelecki's Phys. Descrip.* N. S. Wales, &c., 1845, p. 249, t. 6, f. 2-4.

*Gleichenites odontopteroides*, *McCoy*, *Ann. and Mag. Nat. Hist.*, 1847, xx., p. 147.

? *Cycadopteris odontopteroides*, *Schimper*, *Traité Pal. Vég.*, 1869, i., p. 488.

*Alethopteris? odontopteroides*, *Schimper*, *Ibid.*, p. 569.

*Pecopteris odontopteroides*, *Carruthers*, *Quart. Journ. Geol. Soc.*, 1872, xxviii., p. 355, t. 27, f. 2 and 3.

*Odonopteris odontopteroides*, *Crépin*, *Bull. Acad. R. Belgique*, 1875, xxxix., p. 258, f. 1-5.

*Thinnfeldia odontopteroides*, *Feistmantel*, *Pal. Indica* (Gondwana Flora), 1879, i., Pt. 4, p. 201; ? *Ibid.*, 1881, iii., fas. 3, p. 85, t. 23a, f. 7-9.

" " *Feistmantel*, *Palaeontographica*, 1878, Suppl. Bd. iii., Lief 3, Heft 3, pp. 89 and 106, t. 13, f. 5, t. 14, f. 5, t. 15, f. 3, t. 16, f. 1; *Ibid.*, 1879, Heft 4, p. 165, t. 9 (27), 11 (29).

" " *Ten. Woods*, *Proc. Linn. Soc. N. S. Wales*, 1883, viii., Pt. 1, p. 103.

" " *Curran*, *Ibid.*, 1884, ix., Pt. 2, p. 252, t. 9, f. 4.

*Obs.* A full description of this characteristic Australian fern will be found in the late Rev. J. E. Tenison Woods' Memoir, translated from Feistmantel, with an abridgment of the latter's remarks. The species passes through endless varieties, some of which will no doubt in the future be better for names. This will account for the evident discrepancy which exists between the single figures of various Authors; but when a series of specimens are assembled from a given locality, at which the fern is found in abundance, it is at once seen how these diversified forms all graduate one into the other.

It was doubtless a very large fern, and some idea of this can be gathered from Pls. 9 (27) and 11 (29) of Dr. Feistmantel's Memoir, and before me is an example of no mean size, from Bundanba, measuring ten inches in length. From Ipswich we have examples with the pinnules resembling Feistmantel's Pl. 9 (27), fig. 1, but of rather smaller growth. From Mount Esk is a good terminal pinnule allied to the right hand of the two figures given on the same Author's Pl. 10 (28). At Kilcoy Range occurs a form with the square step-like pinnules resembling Mr. Carruthers' figure; and, lastly, from Petrie's Quarry, Brisbane, we have a specimen bearing a strong resemblance to Morris's original figure in Strzelecki's work (t. 6, f. 4).

In Queensland, *Thinnfeldia* would appear to occupy a relatively higher position than it does in New South Wales. I am not aware of its occurrence below the Hawkesbury Series in the latter Province, but in Queensland it seems to be characteristic of one or more higher horizons.

The nearest allies are, according to Dr. Feistmantel, *T. subtrigona*, Feist., in the Mesozoic rocks of India, and *T. crassinervis*, Geinitz, in similar rocks of the Argentine Republic.

In Pl. 17, fig. 7, is a fern, the right-hand pinnules of which agree with those of *T. odontopteroides*, whilst those on the left agree better with those of *T. media*, Ten. Woods, or even the var. *falcata*, and seems to represent a transition form between the two species (?).

In his Memoir on the Australian Coal Flora, Mr. Tenison Woods mentioned, amongst the fossils of the Ipswich Basin, *Thinnfeldia australis*, but he does not describe such a species.

*Loc.* New Chum, Bundanba, Ipswich Basin, 170 ft. below New Chum Upper Seam, Pl. 17, f. 1 (*R. C. Ringrose*); Redbank, near Mount Esk, Brisbane River, north of Laidley (*W. Souttar*); Kilcoy Range, above Cressbrook (*W. Souttar*); Tivoli Mine, Ipswich (*G. Sweet*—Colln. Sweet, Melbourne).

In addition to these localities, the Macleay Museum contains specimens collected by the late Rev. J. E. T. Woods, and not mentioned in his Paper, from—Aberdare Mine, Ipswich; Rosewood Scrub, near Ipswich; and Pine Mountain, Moreton District.

#### THINNFELDIA ODONTOPTEROIDES, var. FALCATA, Ten. Woods.

*Thinnfeldia odontopteroides*, var. *falcata*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1 p. 107, t. 8, f. 1.

*Obs.* Proposed as a variety for that form of *T. odontopteroides* in which the habit was stouter, and probably not so large in growth. The rachis is always grooved and more slender, and in some specimens the terminal pinnules form a long lanceolate pair.

The ferns from Petrie's Quarry, in my Colleague's Collection, and identified by Mr. R. Kidston as this variety, to some extent resemble it, but the pinnules are hardly decurrent or falcate enough. Mr. Woods, however, says that they become long and falcate as they ascend the rachis, and this is so far borne out by our specimens, in that the upper pinnules are much longer and lanceolate than the lower, the latter retaining more of their normal wedge-deltoid outline.

Closely allied to this variety, in all probability, is that denominated var. *lancifolia* by Morris,\* and which would appear to have been refigured by Feistmantel † without remark, from another specimen. Now the plants from Petrie's Quarry have the upper pinnules shaped like those of var. *lancifolia*, but with the lower ones as above described, and taking upon themselves the more exact outline of *T. odontopteroides*. One or two are even slightly falcate.

*Loc.* Rosewood, near Ipswich (*The late Rev. J. E. T. Woods*—Macleay Museum, University of Sydney); Petrie's Quarry, near Brisbane (*R. C. Ringrose*).

#### THINNFELDIA MEDIA, Ten. Woods ?

Pl. 17, fig. 2, Pl. 18, fig. 10 (compare Pl. 17, f. 7).

*Obs.* For description of the species, see under "Burrum Beds."

*Loc.* Rosewood, near Ipswich (*Rev. J. E. T. Woods*—Macleay Museum, University of Sydney); Colinton, Upper Brisbane River, Pl. 18, fig. 10 (*Hon. A. C. Gregory*); Tivoli Coal Mine (*G. Sweet*—Colln. Sweet, Melbourne). Occurs also in the Burrum Beds.

\* Phys. Descrip. N. S. Wales, &c., 1845, p. xvi., t. 6, f. 4.

† Palaeontographica, Suppl. Bd. iii., 1878, Lief. 3, Heft 3, t. 15, f. 4.

## Family—PECOPTERIDÆ.

*Genus*—*ALETHOPTERIS*, *Sternberg*, 1826.

(Flora der Vorwelt, Heft 4, p. xxi.)

*ALETHOPTERIS AUSTRALIS*, *Morris*, sp., Pl. 16, fig. 1.*Obs.* For description of the species, see "Burruum Beds."

*Loc.* New Chum, Bundanba, Ipswich Basin, fifty feet above the second seam (*R. Archibald*); Gray's Seam, Ipswich (*R. Archibald*); Kilcoy Range, above Creswick\* (*W. Souttar*); Colinton, Upper Brisbane River, Pl. 16, fig. 1 (*Hon. A. C. Gregory*); six miles north of Esk, forty-six miles west-north-west of Ipswich (*W. Souttar*—Mining and Geol. Museum, Sydney); Rosewood, near Ipswich; Peak Mountain, Moreton District; and Fassifern (*The late Rev. J. E. Tenison Woods*—Macleay Museum, University of Sydney); Stewart's Creek, Stanwell (*The late James Smith*).

The plant bed at the last locality consists of a decomposed earthy ironstone, chiefly composed of *Teniopteris* and the pinnules of a Pecopteroid fern. Several of these have the precise venation of *Alethopteris australis*, and I think we must accept this as an additional locality for this species. *Alethopteris australis* occurs also in the Burruum Coal Measures.

*ALETHOPTERIS LINDLEYANA* (*Royle*) *Feistmantel*, Pl. 17, figs. 3 and 4.*Alethopteris Lindleyana* Feistmantel, Palaeontographica, Suppl. Bd. iii., 1878, Lief 3, Heft 3, t. 18, f. 10.

„ *Lindleyana*, Feistmantel, Pal. Indica (Gondwana Flora), 1881, iii., Pt. 3, p. 80, t. 18a, f. 2 and 2a, t. 19a, f. 3 and 4, t. 23a, f. 11, t. 39a, f. 10 and 11.

*Obs.* The small specimen figured (Pl. 17, figs. 3 and 4) is believed both by Mr. Kidston and myself to be identical with Feistmantel's representation of *Alethopteris Lindleyana*, Royle; at any rate it is indistinguishable from his earlier figure. Furthermore, there is a considerable general resemblance to Tenison Woods' representation of *Merianopteris major*, Feistmantel, but in the specimens before me the basal secondary veins do not diverge from the primary vein or midrib in any way different from that usually met with in *Alethopteris*, and certainly not possessing the outward sweep characteristic of *Merianopteris*. It naturally follows that in many Alethopteroid ferns there must be a greater or less resemblance to the vein-arrangement of *Merianopteris*. The resemblance will much depend on the degree to which the pinnules are incised, or cut up. In some cases, and even in the same specimens, the pinnules may be divided almost to the pinna rachis, leaving only so much of their surface confluent as to constitute one of the generic characters. This is apparent in the above figure. When, however, the division between the pinnules is only marginal, or but partial, some of the basal veinlets of contiguous lobes appear in apposition, and in such cases the fern is likely to be mistaken for a *Merianopteris*. Such an appearance is, in reality, widely different from the structure represented in Feistmantel's figures of *M. major*† where the two lower veinlets on each side a pinnule are arched outwards, and in an otherwise clear space devoid of veins, the latter being crowded together towards the apices.

*Loc.* Redbank, near Mount Esk, Brisbane River, north of Laidley (*W. Souttar*).

\* Determined by Mr. R. Kidston.

† Pal. Indica (Gondwana Flora), 1881, iii., Pt. 3, t. 19a, f. 9-11.

## Family—GLEICHENIACEÆ.

Genus—GLEICHENIA, Smith, 1791.

(Mém. Acad. Turin, v., p. 418.

## GLEICHENIA LINEATA, Ten. Woods.

*Gleichenia lineata*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 130, t. 3, f. 6, t. 8, f. 2.

*Sp. Char.* Frond small, coriaceous, with a strong thick rachis, dichotomously divided, pinnate, bi-pinnate. Pinnules entire, linear, attached by almost the whole of the base, but slightly contracted at the lower portion, somewhat distant, not decurrent. Upper edge convex; lower slightly concave, but in a few pinnules divided into deep rounded lobes, apex acute, emerging from the rachis at an angle of about 35°, veins not prominent, costæ not forking, and quite persistent to the apex, not very visible in any of the specimens, but apparently grouped and numerous, emerging at an acute angle, and bifurcating; there appear to be two venules emerging at the very base of the pinnule. Rachis conspicuously marked with a single deep, dark, median groove. (*Ten. Woods.*)

*Obs.* This is said to be closely allied to the recent *Gleichenia flabellata*, R. Brown, common to the east coast of Australia. The Author thinks that perhaps the deep rounded lobes may be a monstrosity. I have not met with the species in my Colleague's gatherings.

*Loc.* Rosewood, near Ipswich (*The late Rev. J. E. T. Woods*—Macleay Museum, University of Sydney).

## Family—TÆNIOPTERIDÆ.

Genus—TÆNIOPTERIS, Brongniart, 1828.\*

(Prod. Hist. Vég. Foss., p. 61.)

## TÆNIOPTERIS (? ANGIOPTERIDIUM) DAINTREEI, McCoy.

*Tæniopteris Daintreei*, McCoy, Trans. R. Soc. Vict., 1860, v., pp. 196 and 215.

,, McCoy, Geol. Survey Vict., Dec. ii., 1875, p. 15, t. 14, f. 1 and 2.

,, Feistmantel, Palaeontographica, 1878, Suppl. Bd. iii., Lief. 3, Heft 3, p. 110, t. 14, f. 2 and 3; *Ibid.* 1879, Heft. 4, p. 169, t. 12, f. 5.

,, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 117.

*Sp. Char.* Frond very long, narrow, strap-shaped, elongately lingual, petiolate, straight, slightly curved, or rather flexuous, parallel-sided, or the margins undulating, or gently sinuous in places, with an average width of five-sixteenths of an inch. Apex rounded, acute, or emarginate. Petiole strong, striated, and naked. Midrib, or costa, thick, striated longitudinally, retaining its size throughout the length of the frond; veins distant or close, simple, or bifurcate, generally at right angles to the midrib, but at times slightly oblique, without curve, dichotomisation taking place near the midrib, or at a variable distance between it and the margin.

*Obs.* I have been, for some time past, accumulating material, with the view of assisting in the identification of some fragmentary Tæniopterid remains from Queensland. *T. Daintreei* was first recognised as a Northern form by Dr. O. Feistmantel, from the Talgai Diggings. I have been favoured from time to time with a *Tæniopteris* from Stewart's Creek, near Stanwell, where the matrix is almost wholly composed of fragments, by my Colleague; from the Peak Mountain, Moreton District, by the late Rev. J. E. T. Woods; and from Starfield, near Mount Morgan, by Mr. A. J. Vogan. In New South Wales, *T. Daintreei* was first recognised in the

\* Restricted, Schimper, Traité Pal. Vég., 1869, i., p. 600.

Clarence Series of Grafton by Mr. E. F. Pittman,\* and we now possess a very excellent series of *Teniopteris* from the Mesozoic Beds of the Talbragar River District.† More recently the late Mr. C. S. Wilkinson collected a series of specimens at Mylne's Gap, about twenty-five miles north-west of Grafton. The identity of the Talbragar River specimens with the typical *T. Daintreei* in the National Museum, Melbourne, has been obligingly confirmed by Prof. McCoy, to whom specimens were sent.

The determination of the united Queensland and Clarence River examples has given me a great deal of trouble, from their fragmentary condition, and variability of characters. Notwithstanding the opinion of Prof. McCoy, to whom specimens were also sent, that these "are specifically distinct from *T. Daintreei*," I have provisionally united these leaves with that species for the following reasons—(a) similarity in the growth and form of the frond; (b) identity in the nature of the venation in all but one point; and (c) absence of other negative characters.

The frond of *T. Daintreei* attained some size, one specimen from the Talbragar River measuring seven inches in length (and then not perfect) by eight-sixteenths of an inch wide. Prof. McCoy states that he had never seen a specimen of this fern more than about four lines wide, but, as individual fronds reached as much as four inches long, it must "have been of a singularly narrow, long, linear shape." It most resembles the English Oolitic *T. vittata*, Phill., but is smaller, very much narrower, and thicker than the latter. All seen by me are separate and detached leaves, no trace of a pinnate arrangement having presented itself, but the general resemblance to those species possessing this character, and for which Schimper proposed the genus *Angiopteridium*, is so strong, that one is insensibly led to refer the present species to it.

The petiole was long and strong, the frond insensibly expanding in width upwards from it, describing either a straight, curved, or flexuose course. In the majority of instances the margin is entire, and the frond in consequence parallel-sided, but examples are before me in which the edges are irregularly emarginate, producing at times almost fantastic outlines. In specimens from the Talbragar River the apices are either rounded or acute, generally the former; but in Queensland examples the rounded apices are sometimes emarginate centrally. These blunt rounded apices are precisely similar to Oldham and Morris's, fig. 5,‡ and to that of Nathorst's *T. (Olean-dridium) obtusa*.§

The direction of the veins in the Talbragar examples, on passing from the midrib is, as described by McCoy, at right angles, but here and there a specimen is met with in which the veins break from the midrib at a decided angle. The bifurcation of the veins into venules is very variable, and does not seem to follow any general rule. It may take place close to the midrib, halfway between the latter and the margin of the frond, or near the last-named.

Whether we take the Clarence River or Queensland specimens, the form and proportions of the fronds are the same, and the venation and its bifurcation are of a similar character, but here there is great variation in the angle of divergence of the veins from the midrib. These discrepancies, however, are all to be seen on one and the same specimen. Thus: some veins are quite at right angles, as in a typical *T. Daintreei* from Victoria, and the Talbragar River examples; others, a few lines away, are inclined upwards;

\* Ann. Report Dept. Mines N. S. Wales for 1879 [1880], p. 227.

† Ann. Report Dept. Mines N. S. Wales, for 1889 [1890], p. 287.

‡ Pal. Indica (Gondwana Flora), 1863, i., Pt. 1, fasc. 5, t. 6.

§ Flor. Skones Kolförande Bilningar, i., 1878, Häft 1, t. 8, f. 10 and 13 (*Sveriges Geol. Undersökning Ser. C.*, No. 27).



and again, here and there, a little downwards. From these facts I am inclined to regard such differences simply as the result of pressure or fossilisation, and, in the absence of other negative evidence, to look upon the whole as one variable species. On the other hand, if, following the valued opinion of Prof. McCoy, we regard the Queensland and Clarence River *Teniopteris* as distinct from the Talbragar and Victorian form, the former can hardly be separated from *Angiopteridium spathulatum*, McClelland,\* a plant possessing fronds of similar size to ours, and a similar variability of venation. Indeed Dr. O. Feistmantel has already remarked on the similarity of this plant to *T. Daintreei*. If future researches should warrant a separation of these various fronds into two species, the only possible characters upon which such a division can be made are the somewhat thicker midrib, and slightly wider-apart venation, characters which are most strongly marked in the examples from Peak Mountain, Moreton District. But here, again, we are met by the Clarence River fronds, which are intermediate between this condition and that of the Talbragar and Victorian forms.

With the above exception, the contiguity of the veins to one another in the Queensland examples is fairly constant, there being three veins in the space of one millimetre, as a general rule. Most of the specimens are fragments, but one or two examples observed measure three and a-half and five inches in length. The breadth varies, of course, according to the part of the frond measured, but basal portions have been found to be as much as thirteen millimetres wide, whilst higher parts of the frond are five in breadth, and at the apices immediately below the tip about three millimetres.

The distal ends or apices of the Queensland fronds are very rare, but in two instances observed the terminations taper very gradually to pointed apices, but without being acute.

As in *T. Daintreei*, so here, some of the veins bifurcate, others do not; when division takes place it is either immediately at the midrib or at about half the distance between it and the margin. In some few cases bifurcation is almost marginal.

The whole of our specimens oscillate between *T. (Angiopteridium) Daintreei*, McCoy, and *T. spathulata*, McClelland, with very strong affinity to the latter, and it even becomes a question if the species be not identical. Speaking of these ferns, Feistmantel remarks: "Of foreign forms the Australian *Tenopteris Daintreei*, McCoy, can, to a certain extent, be compared with this Indian form; but the veins in the former seem to be still straighter and are thicker than in our species."† The latter part of this sentence exactly expresses the difference which exists between the Queensland fossils and McCoy's species, as well as between the latter and the Indian plant. It will not, however, surprise me if these species have to be united; if not, most of the Queensland fronds will have to be referred to *A. spathulatum*, McClelland.

*Loc.* Talgai Diggings, Condamine River (*Dr. O. Feistmantel*—Mining and Geol. Museum, Sydney); Stewart's Creek, Stanwell, near Rockhampton (*R. L. Jack*); Rosewood, near Ipswich (*Hon. A. C. Gregory*); Starfield, near Mount Morgan (*A. J. Vogan*—Mining and Geol. Museum, Sydney); Peak Mountain, Moreton District (*The late Rev. J. E. T. Woods*—Macleay Museum, University of Sydney).

*T. Daintreei* occurs also in the Styx Coal Field (Burrum Formation).

\* Oldham and Morris, *Pal. Indica* (Gondwana Flora), 1863, i., Pt. 1, fas. 5, p. 84, t. 6, f. 1-7; Feistmantel, *Ibid.*, Pt. 2, 1877, p. 96.

† *Pal. Indica* (Gondwana Flora), 1879, i., Pt. 4, p. 207

*TÆNIOPTERIS* (? *ANGIOPTERIDIUM*) *CARRUTHERSI*, *Ten. Woods.*

*Tæniopteris Daintreei*, Carruthers, Quart. Journ. Geol. Soc., 1872, xxviii., p. 355, t. 27, f. 6.

" " Feistmantel, Palaeontographica, 1878, Suppl. Bd., fil., Lief. 3, Heft 3, t. 14, f. 4  
(excl. figs. 2 and 3).

" *Carruthersi*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 117.

*Sp. Char.* Frond simple (?), broad-linear, costæ somewhat thick, veins leaving it at an acute angle, then passing out at right angles to the margin, once or twice dichotomously divided. (*Ten. Woods.*)

*Obs.* This is a larger plant than the original *T. Daintreei* of McCoy, and the general form is different. The veins, instead of leaving the midrib direct at right angles, as in the case of the species named, pass from it at first obliquely, and then assume a similar course to the former. Those points were used by the Rev. J. E. T. Woods for the separation of this plant from *T. Daintreei*, McCoy.

It is, however, but due to Prof. Sir F. McCoy to state that he appears to have been the first to point out \* the difference between the two species, an opinion in which he was supported on three separate occasions by Dr. Feistmantel.† I point this out because the Rev. Mr. Woods appears to have ascribed this matter to the latter observer, although it is of course possible that Dr. Feistmantel may have independently arrived at such a conclusion. The great width of the frond, and the comparatively narrow midrib are striking features in this species, and should, with the venation, always serve to distinguish it. It should be distinctly borne in mind that veins leave the midrib at an acute angle, and then immediately proceed towards the margins horizontally, or at right angles, like those of *T. Daintreei*. At least this is Mr. Woods' statement, but I would observe that in Mr. Carruthers' figure the veins do not diverge at a right angle after leaving the midrib, but at one rather more acute than this, although less than that by which they at first issue from the midrib.

*Tæniopteris Carruthersi* is remarkably like *Angiopteridium Maclellandi*, Old. and Morris,‡ and seems only to possess a wider frond and thicker midrib.

The Geological Survey Collection contains a single leaflet from the Stewart's Creek Beds which partakes in part of the characters of both the species, and I am quite at a loss to which to refer it. The specimen possesses the form of *T. Carruthersi*, and the more numerous and widely diverging veins of *A. Maclellandi*, but I have provisionally referred it to the former.

In Pl. 16, fig. 4, we have a large *Tæniopteris*, at present undetermined, and unfortunately a single specimen. The veins have been drawn as anastomosing, but in reality this is not the case, they simply fork. The leaflet is too large, and the veins too close together for *A. spathulatum*, neither does it correspond with *T. Carruthersi*. Mr. Kidston suggested a reference to *A. Maclellandi*, relying on Zeiller's figure of the plant from Tonkin,§ but this does not correspond with the original illustration of Oldham and Morris. The specimen must for the present remain unnamed.

*Loc.* Tivoli Coal Mine, Ipswich (*The late R. Daintree*)—Redbank; near Mount Esk, Brisbane River, north of Laidley, Pl. 16, fig. 4 (*W. Souttar*). See also under Stewart's Creek Beds, Rockhampton.

\* Geol. Surv. Vict., Dec. ii., 1875, p. 16.

† Pal. Indica (Gondwana Flora), 1879, i., fas. 4, p. 207; Journ. R. Soc. N. S. Wales for 1880 [1881], p. 114; Palaeontographica, loc. cit., Heft 3, p. 110.

‡ Pal. Indica (Gondwana Flora), 1863, Pt. 1, fas. 5, p. 33, t. 23.

§ Ann. des Mines, 1882, ii., t. 10, f. 5.

*Genus—ANGIOPTERIDIUM, Schimper, 1869.*

(Traité Pal. Vég., i., p. 602.)

*ANGIOPTERIDIUM, sp. ind.**Angiopteridium ensis*, Ten. Woods (non Oldham and Morris), Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 119.

*Obs.* The fossil identified by the late Rev. J. E. Tenison Woods with the above species does not appear to accord either with the description or figure of Messrs. Oldham and Morris. In the first place, the Rev. Author's diagnosis and remarks (the first two paragraphs of his observations on this species), which are presumed made on his Australian specimens, are, with one or two trivial alterations, copied *verbatim* from Oldham and Morris, and do not apply in the least degree to the latter.

The original specimens, now in the Macleay Museum, at the Sydney University, were obligingly lent to me by the late Prof. William J. Stephens.

The fronds are long and narrow, nearly three inches, and that without being perfect, ribbon-like, or linear-lingual, hardly tapering, and parallel-sided. The midrib is wide and flattened. The veins are very distinct, wide apart, very oblique to the midrib, and very little curved, being almost straight. They bifurcate at about one-third from the midrib. The veins do not fork particularly near the margin, and the latter is not in any way serrated; the former, measured along the margin, are about one millimetre apart.

The outline of the frond is much more that of *Angiopteridium spathulatum*, but the venation is wholly different. I have not succeeded in identifying this fern with the limited bibliography at my command, but in the event of its being undescribed I propose to name it *A. Tenison-Woodsi*.

*Loc.* Rosewood, near Ipswich (*The late Rev. J. E. T. Woods—Macleay Museum, University of Sydney*).

*Genus—PHYLLOPTERIS, Saporta, 1873.*

(Pal. Franç., Plantes Jurassiques, i., p. 448.)

*PHYLLOPTERIS FEISTMANTELI, sp. nov.*

*Sp. Char.* Frond, or leaflet, oval, or broadly lanceolate, slightly petiolate; midrib very distinct, evanescent towards the apex of the leaflet, but tapering very slowly; veins springing outwards from the midrib at a very acute angle, then gracefully curving outwards to the margin, fine, once or twice furcate.

*Obs.* The form of the leaflet appears to be constant and characteristic, those from Queensland and South Australia agreeing closely. The veins bifurcate first near the midrib, and either proceed in this form to the margin, or again divide at about half the distance between the latter and the midrib. Near the apex the midrib evanesces into a few distributed veins. *Phyllopteris Feistmanteli* is very distinct from Saporta's type, *P. plumula*,\* both in the form of the leaflet, and from the many times dichotomising veins of the latter.

The species is named in honour of the late Dr. Ottokar Feistmantel, formerly Palæontologist to the Geological Survey of India.

At first sight, and when superficially examined, the frond might be taken for a *Glossopteris*; in fact, I had them sent to me by Collectors from Queensland as such. The venation of *Glossopteris* is of the well-known reticulate type, that of *Phyllopteris* is simply furcate; the one being a member of the family Dictyotæniopteridæ, the other of the Tæniopteridæ.

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\* Pal. Franç., Plantes Jurassiques, 1873, i., p. 450, t. 63, f. 6.

The genus *Phyllopteris* is an old one of Brongniart's resuscitated by Count Saporta\* for a plant from the *Ammonites angulatus* zone of the Infra-Lias of the Moselle, France. The portions of fronds from the localities below so thoroughly correspond with the structure of *Phyllopteris*, as described by Saporta, that I have adopted it in the sense of the latter.

The relation of *Phyllopteris* to other Tæniopterids is a very close one, especially those with obliquely curved veins, such as *Angiopteridium*. In the absence of fructification, or the system of branching, it is somewhat difficult to indicate the difference in words, but the fronds in question certainly do not possess the strap-shaped outlines of many *Tæniopteris*, nor the more or less flabellate appearance of *Macrotæniopteris*, but approach nearest to the first-named genus *Angiopteridium*. As, however, the full frond in the latter genus is known to be pinnate with marginal sori, and as nothing whatever is known of these characters in the Queensland and South Australian plant, it will be better for the present to retain it in *Phyllopteris*.

*Loc.* Stewart's Creek, Stanwell, near Rockhampton (*R. L. Jack*); Styx River Coal Shaft, Styx River, Broadsound (*The late James Smith*). I have also received this plant, through the good offices of Mr. H. Y. Lyell Brown, Government Geologist of South Australia, from Cooper's Creek, Central Australia, about one hundred miles due north of the Leigh's Creek Bore.

*Genus*—**MACROTÆNIOPTERIS**, *Schimper*, 1869.

(*Traité Pal. Vég.*, i., p. 610.)

**MACROTÆNIOPTERIS WIANAMATTE**, *Feistmantel*.

*Macrotæniopteris wianamatta*, Feistmantel, *Palaeontographica*, Suppl. Bd. iii., 1878, Lief. 3, Heft 3, p. 107, t. 13, f. 2.

" " Ten. Woods, *Proc. Linn. Soc. N. S. Wales*, 1883, viii., Pt. 1, p. 118, t. 10a.

*Sp. Char.* Frond elongately obovate, simple; base attenuate; apex?; midrib thick, grooved, or striated; veins emerging at angle of 20°-25° close, near the midrib from six to eight-tenths of a millimetre apart, slender, dichotomous towards the margin. (*Ten. Woods*.)

*Obs.* The late Rev. J. E. Tenison Woods recorded this fern from Ipswich, but added that the dichotomy of the veins is near the rachis, and suggested that in consequence it might be a new species. The presumption is, of course, that the veins divide nearer the midrib than do those in Feistmantel's type, but on consulting the latter's figure, it will be noticed that subdivision takes place at various distances between the margin and the midrib. This separation will hardly, therefore, hold good.

*Loc.* Ipswich (*The late Rev. J. E. Tenison Woods*—Macleay Museum, University of Sydney).

**MACROTÆNIOPTERIS CRASSINERVIS**, *Feistmantel*? Pl. 16, fig. 5.

*Macrotæniopteris crassinervis*, Feistmantel, *Pal. Indica* (Gondwana Flora), 1877, i., Pt. 2, p. 102, t. 38, f. 1-3.

*Sp. Char.* Frond very large, single, strong, thick, and coriaceous, broad, elongately obovate; margins plain; apex obtusely rounded, not re-entrant; midrib distinct, but not wide for the size of the frond, vertically ridged; veins, except near the apex, diverging at a right angle, or nearly so, very strong; distant from one to one and a-half millimetres apart, very regular and direct in their course, simple or forked; dichotomisation at irregular intervals, but always dividing close to the midrib.

*Obs.* I have ventured to refer this noble frond to Feistmantel's *Macrotæniopteris crassinervis*, from its coarse nervation, and the uniform manner in which the veins

\* *Pal. Franç.*, *Plantes Jurassiques*, 1873, i., p. 448.

divide close to the midrib. The Author remarks of his species—"The chief character, however, lies in the secondary veins; they were not numerous, and somewhat distant from each other, showing regular intervals." The number, of course, depends upon the size of the frond, but otherwise these remarks quite coincide with the characters of our frond. I am unable to make a closer comparison than with the above species, but Feistmantel remarks that *M. crassinervis* "was of no very large size." Herein lies a marked departure from our fern, and may perhaps constitute a difference, in which case I should feel disposed to regard this as undescribed, at any rate so far as Australian species are concerned.

As preserved, the frond is fifteen inches in length, and, if perfect, would measure fully five in breadth. Want of space does not enable me to figure this fine fossil, but the apical portion of a second specimen on the same slab of stone is given (Pl. 16, fig. 5). As regards size, the only species with which it is in my power to compare it is *M. lata*, O. and M.,\* but here the frond is very delicate, and the veins fine and close, producing a far more tender leaf than that under consideration.

The veins in the Australian specimen are fully one millimetre apart, and frequently one and a-half. Their regularity is a very marked feature, and the angle of divergence is usually a right angle, or but very slightly removed from it. No rule seems to exist as to the order of subdivision of the veins, but when they are dichotomous the split always takes place in close contiguity to the midrib. It is only towards the apex that the divergence assumes another angle, and then it is much more acute. The apex of the frond is shown in a second specimen, about six inches long, on the same slab. It is obtuse, but at the termination of the midrib sub-mucronate. Two and a-half inches from the apex the width of the frond is three inches.

*Loc.* Wycarbah, near Rockhampton (*The late James Smith*).

#### MACROTENOPTERIS, *sp.*

*Obs.* A portion of a frond which was originally at least four inches wide, generally resembles that of *M. wianamattæ*, Feistm. On emerging from the midrib, or costa, the veins are strong and about one thirty-second of an inch apart, but after bifurcation they become exceedingly fine and close together. The subdivision takes place near the rachis, and in this it differs from the species above named, in which bifurcation is much nearer the margin of the pinnule. The late Rev. J. E. Tenison Woods remarked, when speaking of *M. wianamattæ*, "I have some similar specimens near Ipswich, but the dichotomy of the veins is near the rachis, and it may be a distinct species." I take it that the present fossil is a similar one to that mentioned by the Reverend Author, and if it should prove distinct, as I anticipate it will, it may be known as *Macrotæniopteris Woodsi*. An early opportunity will be taken to figure this interesting plant.

*Loc.* Tivoli Coal Mine, Ipswich (*G. Sweet—Colln. Sweet, Melbourne*).

#### Genus—*SAGENOPTERIS*, Presl.

(Sternberg's *Flora der Vorwelt*, ii.†)

#### *SAGENOPTERIS RHOIFOLIA* (Presl.), Feistmantel.

*Sagenopteris rhoifolia* (Presl.) Feistmantel, *Palæontographica*, 1879, Suppl. Bd. iii., Lief. 3 Heft 4, p. 170, t. 30, f. 1-4 and 7.

, , Ten. Woods, *Proc. Linn. Soc. N. S. Wales*, 1883, viii., Pt. i., p. 123, t. 9, f. 4.

*Sp. Char.* Frond very variable both as to shape and size; pinnae narrow at the base, articulate, spatulate, obovate, or oblong-acuminate, rarely oblong-lanceolate or

\* *Pal. Indica* (Gondwana Flora), 1863, i., Pt. 1, fasc. 6, t. 1, t. 2, f. 1, t. 4, 1 and 2, t. 5, &c.

† *Fide* Schimper, *Traité Pal. Vég.*, i., p. 641.

subrotundate, inequilateral, very rarely subsymmetrical, the middle leaves larger than the lateral ones, and quite entire. Ordinary length about thirty-two millimetres, with a diameter of sixteen millimetres. The internal margins of the lateral fronds somewhat expanded, furnished here and there with a broad indistinct dental lobe. (*Ten. Woods.*)

*Obs.* I have examined the type specimens used by the late Rev. J. E. T. Woods, which are very beautifully and distinctly preserved in the ferruginous rock of the Darling Downs deposit. Some specimens in the Australian Museum measure as much as three and three-quarter inches in length.

Dr. Feistmantel records this species from the Talgai Diggings, but Mr. Woods says, "All Australian specimens are from the Upper or Mesozoic Coal Basins of Ipswich, Queensland, and Jerusalem, Tasmania."

*Loc.* Talgai Diggings, Condamine River (*Dr. O. Feistmantel*—Mining and Geol. Museum, Sydney); Darling Downs, near Toowoomba (*The late Rev. J. E. T. Woods*—Macleay Museum, University of Sydney).

#### SAGENOPTERIS ? CUNEATA, *Carruthers*, sp.

*Cyclopteris cuneata*, Carruthers, Quart. Journ. Geol. Soc., 1872, xxviii., p. 355, t. 27, f. 5.

" " Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 109.

*Sp. Char.* Pinnæ entire, generally large, cuneate-triangular, narrowed towards the base, and more or less petiolate-like, and the distal margin obliquely rounded, veins delicate, but distinct and very regular, about one-thirty-secondth of an inch apart, once or twice dichotomously divided, sometimes anastomosing at intervals, and then forming a long narrow oval mesh; no trace of a costa or midrib.

*Obs.* Both Dr. Feistmantel and the late Rev. J. E. Tenison Woods were inclined to the belief that the original figure represented but a fragment of a pinna. This, and the anastomosis of the veins, described by Mr. Carruthers, led both Authors to doubt the reference to *Cyclopteris*, Mr. Woods remarking that "some fragments of *Sagenopteris* may resemble it."

Mr. George Sweet has obtained a specimen from Tivoli, with a distinctly cuneate-triangular outline, and perfect. Mr. Carruthers describes the veins as "sometimes anastomosing once in their length near the middle of the pinnæ," but Mr. Sweet's specimen clearly shows that it took place more frequently than this, and, when present, divided the leaf into an imperfect oval network. I have provisionally placed the species in *Sagenopteris*, although it does not conform strictly to the characters of that genus. It need not in any way be mistaken for a *Glossopteris*, the outward curve of the veins, the absence of a midrib, and the paucity of the vein-reticulation quite separating *S. ? cuneata* from that genus.

*Loc.* Tivoli Coal Mine (*The late R. Daintree*; *G. Sweet*—Colln. Sweet, Melbourne).

#### Family—DICTYOPTERIDÆ.

##### *Genus*—PHLEBOPTERIS, *Brongniart*,\* 1828.

(Prod. Hist. Vég. Foss., p. 30.)

##### PHLEBOPTERIS ALETHOPTEROIDES, *Etheridge* fil.

*Phlebopteris alethopteroides*, Etheridge fil., Proc. Linn. Soc. N. S. Wales, 1888, iii., Pt. 3, p. 1306, t. 38 f. 1 and 2; *Ibid.*, 1889, iv., Pt. 3, p. 625.

*Sp. Char.* Pinnæ large, probably elongate. Rachis strong, moderately thick or wide, and longitudinally grooved and ridged. Pinnules lingual, strap-shaped, narrow,

\* Emend. Schimper, *Traité Pal. Vég.*, 1869, i., p. 624.

very long, parallel-sided, alternate, sub-alternate or opposite, very regular in appearance, and equidistant, markedly confluent. Midrib strong, tapering gradually, and extending to the apices of the pinnules; reticulation small, consisting of elongate, rather irregular scale-like vesicles; veins almost at right angles to the midrib, bifurcating immediately after leaving the reticulation.

*Obs.* Amongst a collection of plants in the Australian Museum, from the Ipswich Coal Measures on the Darling Downs, near Toowoomba, I observed some fairly good specimens of what appeared to be *Alethopteris*; but the narrow elongate pinnules, springing horizontally from the rachis, did not allow the plant in question to fit happily into that genus. Close examination of the better-preserved examples, revealed a small and very delicate reticulation, consisting of small, elongate, and irregular vesicles, if I may call them so, lying close to the midrib of each pinnule. The appearance presented by this reticulation is very well shown in Schimper's figure of *Phlebopteris affinis*, Schenk.\*

Portions of this fern, which I have called *Phlebopteris alethopteroides*, are as much as seven inches in length, so that the pinnæ must have attained a no mean size. Individual pinnules, although imperfect, still measure two and a-half inches in length, their breadth, which is very disproportionate to the length, remaining very uniform. The greatest width I have observed a pinna to attain, and that again imperfect, was four and a-quarter inches. The pinnules are, on an average, from a quarter of an inch to five-sixteenths wide, and are separated from one another by interspaces of about a quarter their width. A good deal of irregularity exists in the manner in which the midribs of the pinnules are given off from opposite sides of the rachis. Some are opposite, others are regularly alternate, many are sub-alternate, and others are even intermediate between these positions.

The veins are very regular, and given off at an angle which slightly varies from a right angle with the midrib, to one more acute. They bifurcate shortly after leaving the reticulation, and proceed direct to the margin. Along the rachis, on the confluent portions of the pinnules, the veins are longer and much wider apart.

The rachis is always broad and well marked, being rigid and fluted; and it may not be uninteresting to note a segmentation of the stem in some of the specimens, and always at the base of the pinnules, but arising only from fracture.

The regularity and stoutness of the rachis and pinnules give to this fern, especially when not too well preserved, almost the aspect of a Cycad.

In the form of the network on each side the midrib, our species is much like the figure of *P. contigua*, L. and H., given by Lyell † under the name of *Hemitelites Brownii*, Göpp.

The fructification is shown on a specimen in the Mining and Geological Museum, Sydney, the position of the sori being similar to that of Brongniart's *P. polypodioides*—viz., at the ends of short nervules which do not reach the margin of the pinnules. The fructification in its present state is stellate and occupies a large portion of the pinnule surface, and in its minute structure much resembles that of *P. Schouvii*, Brong. It would seem that the indusium had in each case burst, leaving the interior of the sori exposed, in which case the sporangia are represented by the small radiating subdivisions.

*Loc.* Darling Downs, near Toowoomba (*The late O. H. Hartmann*—Australian Museum, Sydney).

\* *Loc. cit.* Atlas, t. 39, fig. 15.

† Student's Elements of Geology, 2nd Edition, 1874, p. 337, f. 357.

## Section—PHANEROGAMIA.

## Class—DICOTYLEDONES.

## Order—CYCADACEÆ.

## Family—ZAMIEÆ.

Genus—*PODOZAMITES*, F. Braun.

(Münster's Petrefactenkunde, vi., p. 36.)\*

*PODOZAMITES LANCEOLATUS*, Lindley and Hutton?*Zamia lanceolata*, L. and H., Fossil Flora, 1837, iii., t. 194.*Podozamites lanceolatus*, Feistmantel, Pal. Indica (Gondwana Flora), 1877, ii., Pt. 2, p. 11 (91), t. 3, f. 7-14, t. 4, f. 1-10.

" " Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. i., p. 145.

*Sp. Char.* Leaves remote, deciduous, entire, narrowed at base, lanceolate, acuminate at the apex; nerves many, forked just above the base, then simple, and converging to the apex, parallel, from eight to twelve in a leaf. Leaves from forty-five to one hundred millimetres in length, and from two to twelve in breadth, according as the leaf is ovate or lanceolate, (*Ten. Woods.*)

*Obs.* The above is the late Rev. J. E. Tenison Woods' description of the Australian plant. The determination is open to some doubt, as the Reverend Author seems to have hesitated between *P. lanceolatus* and *Zeugophyllites elongatus*, Morris. Denuding his remarks of quotations from other Authors, he says: "Both these varieties (*i.e.*, the Indian) occur abundantly in the Ipswich Basin, one specimen showing how the leaves were affixed to the parent stem, and, though the fragment is imperfect, it shows precisely the growth figured by Schimper . . . . This plant may have been the same as *Zeugophyllites australis*, Morr. It must be remembered that the latter genus was established by Brongniart for a plant with leaflets such as these, but in pairs."

*Loc.* Ipswich Basin (*The late Rev. J. E. T. Woods*—Macleay Museum, University of Sydney).

*PODOZAMITES*, *sp.*, Pl. 18, fig. 5.

*Obs.* Leaflets somewhat similar to those described from "Burrum, above the Bridge Seam—Hon. W. Walsh" (Pl. 18, fig. 4), are presented in this specimen, but larger and displaced with respect to one another. The venation is stronger than in the previous form, and the apices blunter, although that of the larger pinnule does not represent a true margin, but a fractured edge. There are about eight veins in the space of half an inch. This approaches nearest to *Podozamites Zeillerianus*, Zigno,† an Italian species, both in size and nature of the venation, except that in our plant the veins occasionally bifurcate, whilst in the former they are simple.

Similar broad pinnules are figured by Schenk, in Richthofen's "China," as *Podozamites lanceolatus*, var. *latifolia*. Here,‡ on the whole, they appear much more finely veined than our Pl. 18, fig. 5, but some have acute apices, as in Pl. 18, fig. 4.

The questionable occurrence of *Zeugophyllites* in Queensland rocks has already been referred to under *Podozamites lanceolatus*. From Mount Esk some long and fragmentary striated and simple leaves have come under notice, which Mr. R.

\* *Fide* Zigno, Flora Foss. Formationis Ool., Vol. ii., p. 118.

† Zigno, Flora Foss. Formationis Ool., ii., p. 130, t. 41, f. 1-6.

‡ Beiträge zur Paläontologie von China, 1883, Bd. iv., t. 49, f. 5, t. 50, f. 4, t. 51, f. 6.



Kidston suggested might be those of *Zeugophyllites*. They are certainly like those of *Z. elongatus*, Morris, but it seems to me that their length is too great in proportion to their width, and the margins too parallel for a leaf possessing the somewhat tapering outline of the species named. The leaves are striated faintly, and associated with *Thinnfeldia odontopteroides*, and *Tæniopteris*. These leaves are, I think, much more likely to be those of *Podozamites*, leaving out of question the relation of the latter and *Zeugophyllites*.

*Loc.* Redbank, near Mount Esk, Brisbane River, north of Laidley (*W. Souttar*).  
See remarks on the specimen, Pl. 18, fig. 4, under the head "Burrum."

*Genus*—*OTOZAMITES*, *F. Braun*.

(Münster's *Petrefactenkunde*, vi., p. 36.)

*OTOZAMITES MANDESLOHI*, *Kurr*.

*Otozamites* (comp. *Mandeslohi*, *Kurr*), *Feistmantel*, *Palaeontographica*, 1879, Suppl. Bd. iii., Lief 3, Heft 4, p. 171, t. 12, f. 6.

" *Mandeslohi*, *Ten. Woods*, *Proc. Linn. Soc. N. S. Wales*, 1883, viii., Pt. 1, p. 151.

*Sp. Char.* Leaves long linear, gradually narrowed towards the apex, twenty-five millimetres wide, leaflets densely crowded, oblique, alternating, inserted on the rachis with contiguous bases, ovate, oblong, obtuse, base subcordate, fourteen millimetres long, eight broad; nerves close, diverging. (*Ten. Woods*.)

*Obs.* The Australian plant is believed by Dr. Feistmantel to be identical with that from the Lias of Wurtemberg.

*Loc.* Talgai Diggings, Condamine River (*Dr. O. Feistmantel*—Mining and Geol. Museum, Sydney); Darling Downs, near Toowoomba (*The late Rev. J. E. T. Woods*—Macleay Museum, University of Sydney; *The late O. H. Hartmann*—Australian Museum, Sydney).

*Genus*—*PTEROPHYLLUM*, *Brongniart*, 1828.

(*Prod. Hist. Vég. Foss.*, p. 95.)

*PTEROPHYLLUM ABNORME*, *sp. nov.*, Pl. 17, fig. 5 and 6.

*Sp. Char.* Pinnæ probably long and narrow; pinnules small, narrow, quite parallel-sided, alternate, or sub-alternate, decurrent, attached by their whole bases, generally distinct from one another, but sometimes slightly confluent, not constricted at the base; apices broadly rounded and not in any way acuminate; veins distinct, about ten at the basal end of pinnules, each bifurcating at about half the length of the leaflet, direct, not converging towards the apex; rachis not very broad, distinct, and longitudinally striate.

*Obs.* A few examples of this plant have come under my notice, but all presenting similar characters. Strictly speaking, the dichotomy of the veins would remove the species from *Pterophyllum*, where they are always described as simple. On the other hand, in those genera in which the simplicity of the venation is lost, the pinnules are either inserted on the rachis by a callosity, as in *Zamites*; with an articulated base, as in *Otozamites*; by an attenuated and articulated base like *Podozamites*; or partially united, as in *Ptilophyllum*. In the present case the pinnules are most certainly decurrent, and for that reason I prefer to provisionally retain the plant in *Pterophyllum*.

In the form of the pinnules and their separation from one another, there is a general resemblance to *Pterophyllum Falconerianum*, Morris,\* but the fronds of this species are larger, and the veins simple.

*Loc.* Redbank, near Mount Esk, Brisbane River, north of Laidley (*W. Souttar*).

\* *Pal. Indica* (*Gondwana Flora*), 1863, i. Pt. 1, fas. 3, t. 14, f. 1.

*PTEROPHYLLUM, sp. ind.*, Pl. 16, fig. 3.

*Sp. Char.* Form of frond unknown. Rachis moderately broad, longitudinally wrinkled. Pinnules long, transversely elongated, parallel-sided, apices unknown, expanding slightly towards the base of attachment, in one instance almost confluent, alternate, but moderately contiguous to one another. Veins strong, well-marked, apparently about twenty.

*Obs.* A single example, and that fragmentary, does not permit of a species being established, although, so far as Queensland is concerned, there is no doubt this is quite new.

It appears to partake of the character of *P. Falconerianum*, Morris.\*

This is not unlike some forms of *Zamites*, but, although one or two of the bases of the pinnules appear a little thickened, I do not see any trace of a callosity in the sense as applied to that genus.

*Loc.* Colinton, Upper Brisbane River (*Hon. A. C. Gregory*).

Genus—*PTILOPHYLLUM*, Morris, 1840.

(*Trans. Geol. Soc.*, 1840, v.)

*PTILOPHYLLUM OLIGONEURUM*, Ten. Woods.

Pl. 18, fig. 11, and ? Pl. 16, fig. 2.

*Ptilophyllum oligoneurum*, Ten. Woods, *Proc. Linn. Soc. N. S. Wales*, 1883, viii., Pt. 1, p. 149, t. 7, f. 2-4.

*Sp. Char.* Frond pinnate, long linear, gradually tapering to the apex; pinnæ rather long, narrow, slightly oblique, alternate, separate, but very close, rounded and curved, somewhat falcate, ending in quite an acute apex at the upper edge, base rounder or auriculate above, obliquely inserted, leaving when detached a series of oblique, alternate, elongate depressions on the rachis; veins distinct from their origin, and parallel to the apex, from four to six in number, all well marked and conspicuous. Length of longest pinnæ twelve to fifteen millimetres, breadth one and a-half to two millimetres. (*Ten. Woods.*)

*Obs.* "The species . . . partakes of an intermediate character. It has the acute leaflets of *P. acutifolium* and the small size of *P. cutchense*, and furthermore is distinguished from both by its few, simple parallel veins."

I much question the distinctness of this plant from some varieties of *P. acutifolium*, Morris,† to which in fact Mr. Kidston had referred our specimens.

*Loc.* Rosewood, near Rockhampton (*The late Rev. J. E. T. Woods—Macleay Museum, University of Sydney*); Wycarbah, near Rockhampton (*R. L. Jack, and the late James Smith*).

## Order—CONIFERÆ.

*Obs.* The following epitome of our knowledge of Australian Fossil Coniferæ is quoted from the late Rev. J. E. Tison Woods' Memoir:—"We have abundant evidence of the existence of Conifers in Australia, in almost all our plant beds except the very earliest coal formations.‡ This is necessary to bear in mind, because Morris, in Strzelecki's Work already referred to, lays stress upon the absence of such woods from the New South Wales specimens. Wood, leaves, and scales of conifers are mentioned by Dana. Many specimens of coniferous wood are reported to occur in the Lower

\* *Pal. Indica* (*Gondwana Flora*), 1863, i, Pt. 1., fas. 3, t. 16, f. 1.

† *Pal. Indica* (*Gondwana Flora*), 1863, i., Pt. 1, fas. 4, p. 29, t. 20, f. 2.

‡ Even this exception need no longer be made. See pp. 49 and 198.

Coal Measures, Greta Creek. Wood and leaves are found in the Jerusalem Coal Basin in Tasmania, and both are common, as we have seen, in the Ipswich Coal Beds, and in the Tivoli Mines in Queensland.

"Fragments of a kind of jet, in which, however, the coniferous structure is very visible, are common also in the Desert Sandstone in Queensland. Finally, there are some fossil *Walchia*, which evidently bore a large share in forming the coal at Ballimore."

The late Mr. James Smith collected coniferous wood at Wycarbah, near Rockhampton (Pl. 4, figs. 9 and 10). Our figures have hardly been enlarged enough to show the complete structure, but in the specimen from which they are taken it is very finely preserved. They are portions of a Cupressinous Conifer, allied to, if not identical with, *Spondylostrombus*, von Mueller. Pl. 4, fig. 9, is a radial section showing the medullary rays in horizontal lines, and the woody fibres in vertical lines. Fig. 10 is a transverse section, the walls and cavities of the woody fibres shown in quadrangular spaces, but the resin ducts are not visible. The latter, however, Baron von Mueller informs me, are frequently not visible in *Spondylostrombus*. The Baron has examined these slides and assents to their reference to his genus. Mr. Smith informed me that the block of wood was not found *in situ* at Wycarbah, but, with many others, lay scattered over the surface of some miles of country, and, in fact, that such fragments are common everywhere in Central Queensland. From this it is exceedingly doubtful if it belongs to the plant-bearing series at Wycarbah; in fact, the evidence is pretty conclusive that it does not. On the contrary, the wood is probably derived from the denudation of some later formation now swept away.

#### Family—ARAUCARIÆ.

##### Genus—*ARAUCARITES*, Sternberg.

(Flora der Vorwelt, ii., p. 203.)

##### *ARAUCARITES* ? *POLYCARPA*, Ten. Woods, Pl. 18, fig. 1.

*Araucarites* ? *polycarpa*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 165.

„ *australis*, Ten. Woods, *Ibid.*, t. 10, f. 1.

*Obs.* The late Mr. Woods did not give a description of this cone, but the few characters now offered are taken from our specimen—which, although much smaller, may possibly be the above species. The cone was probably elongate, and perhaps cylindrical; the scales are rhomboidal, with a subapical mucro, or stout blunt spine, but do not appear to be ridged in the true sense of the word, nor divided into an upper or lower portion; in each oblique row on the side visible there are about ten scales.

Now, irrespective of the size of the cone, there are obviously a less number of scales in each spiral series in this specimen (Pl. 18, fig. 1) than in Woods' figure of *A. ? polycarpa*, and I think it questionable if the two can remain under the same name, an opinion in which I am sustained by that of Mr. B. Kidston. In passing, a reference might be made to those plant-remains from the South Australian Mesozoic rocks, named by Dr. H. Woodward *Mantellia babbagensis*,\* which bear a general resemblance to our fossil. In addition to this cone, my Colleague has lately communicated to me an almost complete impression, too late to be figured, of one four inches long with a diameter rather exceeding three-quarters of an inch. It is a hollow external cast contained in an ironstone nodule rather similar to Mr. Woods' example. The diameter of the present specimen is less than the latter, but the length is greater.

\* Geol. Mag., 1885, ii., p. 290, t. 7, ff. 1 and 2.

The scars were approximately rather smaller, and about the size of those in the figure now given. So far as the specimen is preserved, thirty leaf-scales are visible in an oblique row, and probably as many more would be so were the fossil complete. Woods' cast is much broader at the base, and less cylindrical than that just described. The leaf-scales are two millimetres in vertical diameter, and about the same in the contrary direction.

*Loc.* Stewart's Creek, near Rockhampton (*R. L. Jack*).

### Family—TAXODIACEÆ.

*Genus*—*SEQUIOITES*, *Carruthers*.

*SEQUIOITES ? AUSTRALIS*, *Ten. Woods*.

*Sequoiites australis*, *Ten. Woods*, *Proc. Linn. Soc. N. S. Wales*, 1883, viii., Pt. 1, p. 162, t. 7, f. 5.

*Sp. Char.* Leaves very close, two-rowed (?), spread out, flat, alternate, rarely falcate, smooth above; midrib prominent below, rounded at the apex, towards which there is only a very slight tapering, not contracted at the base but becoming a sheath, down the centre of which the midrib can be distinctly traced, from twenty to twenty five millimetres long, and one and a-half wide, but much shorter and smaller near the extremities of the shoots, where they are somewhat imbricated all round the branch, and loosely spiral; the sheathing base of the leaves gives rise to a jointed appearance to the stem. (*Ten. Woods*.)

*Obs.* The Author justly speaks very cautiously of his reference of this plant, only known from foliage, to *Sequoiites*, "as no cones, either male or female, have been hitherto discovered." He adds—"We have no Australian conifer with leaves similar to *Sequoia* except *Podocarpus*, but though in some species of that genus the foliage is long, flat, and with a prominent midrib, there is a distinct petiole, which in this fossil is wanting."

*Loc.* Rosewood, near Rockhampton (*The late Rev J. E. T. Woods*—Macleay Museum, University of Sydney).

### Family—TAXACEÆ.

*Genus*—*TAXITES*, *Brongniart*, 1828.

(*Prod. Hist. Vég. Foss.*, p. 108.

*TAXITES MEDIUS*, *Ten. Woods*.

*Taxites medius*, *Ten. Woods*, *Proc. Linn. Soc. N. S. Wales*, 1883, viii., Pt. 1, p. 160, t. 9, f. 3.

*Sp. Char.* Branchlets thin; leaflets spirally and bilaterally disposed, emerging at an acute angle, sub-alternate, sometimes slightly curved outwards, narrow, linear, obtuse, rather long; the decurrent pedicel thick, long, and broad (nearly as broad as the leaf at times), midrib thick and conspicuous, surface shining and transversely wrinkled. (*Ten. Woods*.)

*Obs.* This is intermediate in character between the two Indian species *T. tenerimus*, Feist., and *T. planus*, Feist. In the first of these the leaflets are very small and horizontal, but in the second the leaflets are much broader and longer, although horizontal also.

*Loc.* Ipswich (*The Rev. J. E. T. Woods*—Macleay Museum, University of Sydney).

Genus—*BRACHYPHYLLUM*, Brongniart, 1828.

(Prod. Hist. Vég. Foss., p. 109.)

*BRACHYPHYLLUM CRASSUM*, Ten. Woods, Pl. 18, fig. 2.*Brachyphyllum crassum* (aut. var. *B. mamillare*!) Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, vii., Pt. 4, p. 660.,, *australe*, var. *crassum*, Ten. Woods, Loc. cit., 1883, viii., Pt. 1, p. 159, t. 5.

*Sp. Char.* Plant robust, thick; stem and branches repeatedly dichotomous; leaves thick and fleshy, densely crowded, homodromous, short, broad, obtuse, conspicuously keeled, erect, closely imbricate, but slightly spreading; branches and branchlets very little narrower than the parent stem, and of equal width to the summit; all portions of the plant curved, three leaves visible in each spiral, and about three rows in one centimetre. Length of leaves, from two to three millimetres; breadth, from five to six; diameter of cauline stem at widest part, ten millimetres; of branchlets, eight millimetres; length of shortest, eighteen millimetres. (*Ten. Woods.*)

*Obs.* This is a very interesting plant, as the leaf-scars resemble those of *Lepidodendron*.

Mr. Woods seems to have been in much doubt as to the name his fossil should bear. At p. 54 of the Memoir cited\*, in the list of Queensland Jurassic plants, he mentions *Brachyphyllum mamillare*, but on p. 62 he gives *B. mamillare*, var. *crassum*, whilst to the description on p. 159 is appended the name *B. australe*, var. *crassum*. By what name, therefore, is this plant to be known? With the view of avoiding this confusion I have adopted his varietal name as the specific one, particularly as I believe the plant in question to be distinct from Feistmantel's species. This will also avoid any confusion with *Mamillaria Desnoyersii*, which appears to have been dragged in without any special object. If Mr. Woods intended to convey the idea that his *B. crassum* is identical with the latter, why did he not adopt it as the specific name for the Queensland plant at once? From the respective descriptions and figures of Feistmantel and Woods, it seems to me that their species are distinct. In *B. australe* the leaves are said to be flattened and sub-keeled; in *B. crassum* they are described as conspicuously keeled. These points are borne out by the Author's figures. In fact, the short, broad, and obtuse leaves on the branchlets of *B. crassum* correspond much more closely with the somewhat similar leaves on the amentum of *B. australe* than they do with the rhomboid oblong leaves on the branchlets of the latter.

*B. crassum* is said by its describer to closely resemble the European *B. mamillare*, Brong., but to differ from the latter, and all other known forms, in the thickness and shape of the leaves, and the continuous branching without diminution of diameter. The leaves are covered with a fine granulation, and have slightly raised margins. Mr. Woods adds that the sharp and raised keel is not visible on all leaves. A specimen before me, from Clifton Colliery, has some of the leaves keeled, others not, but all with a more or less thickened margin.

On examining the figured type I find the characters laid down by Mr. Woods as quite correct, and it is clear that where the vertical ridges have disappeared the plant has been subjected to much pressure. The main branch of this specimen is six inches long, and eleven millimetres wide, whilst the scales are from three to five millimetres in transverse measurement. When really well preserved the leaf-scales have the form of our Pl. 18, fig. 3, terminating upwards in a short mucro. This makes me hesitate the less in referring this specimen also to *B. crassum*. In the example from the Walloon Mine,

\* Author's separate copy.

on the contrary, no edges or mucro are preserved, nevertheless it corresponds perfectly with those portions of Woods' type which are crushed. There is a very close resemblance between *B. crassum* and *B. Papareli*, Saporta.\*

*Loc.* Tivoli Mine, Ipswich (*The late Rev. J. E. T. Woods*—Macleay Museum, University of Sydney); Clifton Colliery, Ipswich (*R. L. Jack*); Rosewood, near Ipswich, in ash-beds (*Hon. A. O. Gregory*).

*Genus*—*CUNNINGHAMITES*, Sternberg.

(*Flora der Vorwelt*, ii., p. 203.)

*CUNNINGHAMITES AUSTRALIS*, Ten. Woods.

*Cunninghamites australis*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 1, p. 165, t. 3, f. 1-3, t. 4, f. 1.

*Sp. Char.* Leaves long, linear, pointed, decurrent, entire; male amenta in rather thick corrugated clusters at the ends of the branches, generally two are alone distinct in the fossil, but others can always be traced in the centre; amenta curved. (*Ten. Woods.*)

*Obs.* The indistinctness of the figures quoted renders it impossible to follow the specific characters laid down by Mr. Woods. He remarks that the presence of the male amenta renders "the identification of the genus much more certain. The leaves, however, are seldom entire, which gives the appearance of an obtuse or unequal foliage."

*Loc.* Rosewood, near Ipswich (*The late Rev. J. E. T. Woods*—Macleay Museum, University of Sydney).

**PLANTÆ INCERTÆ SEDIS.**

*Genus*—*CARDIOCARPUM*, Brongniart, 1828.

(*Prod. Hist. Vég. Foss.*, p. 87.)

*CARDIOCARPUM ? AUSTRALE*, Carruthers.

*Cardiocarpum australe*, Carruthers, Quart. Journ. Geol. Soc., 1872, xxviii., p. 356, t. 27, f. 4.

„ *? australe*, Feistmantel, Palaeontographica, 1878, Suppl. Bd. iii., Lief. 3, Heft 3, p. 112.

*Sp. Char.* Fruit cordate, with an acuto apex, and a ridge running along one side of the fruit within and parallel to the edge; seed ornate, acute. (*Carruthers.*)

*Loc.* Tivoli Coal Mine, Ipswich (*The late R. Daintree*).

*Genus*—*CYCADINOCARPUS*, Schimper.

(*Traité Pal. Vég.*, ii., p. 208.)

*Obs.* A name proposed for the seeds of Cycadaceous plants. They are sub-globose, ovate, or oblong fruits, usually associated with stems and leaves of plants of that order. In Pl. 16, fig. 10, such a seed is represented, and resembles very closely *Cycadinocarpus rajmahalensis*, Feistmantel.†

*Loc.* Wycarbah, near Rockhampton (*The late James Smith*).

\* *Pal. Franç. Terr. Jur. Vég.*, iii., t. 33.

† *Pal. Indica (Gondwana Flora)*, 1877, i., Pt. 2, p. 132 (80), t. 35, f. 10.

Kingdom—**ANIMALIA.**Sub-Kingdom—**ARTHROPODA.**Class—**CRUSTACEA.**Order—**PHYLLOPODA.**Family—**LIMNADIDÆ.**

*Genus*—**ESTHERIA**, Rüppell and Straus, 1837.

(Mus. Senckenberg, 1837, ii., p. 119.\*)

**ESTHERIA MANGALIENSIS**, Jones.

*Estheria mangaliensis*, Jones, Mon. Foss. Estheriæ, 1862, p. 78, t. 2, f. 16-23.

*Sp. Char.* Valves broadly subovate, hardly convex; dorsal margin straight, about half the length of the valves, terminated at the anterior end by the umbones; anterior, posterior, and ventral margins fully and broadly rounded, the anterior shorter than the posterior, rendering the valves narrower at the former of the two ends; umbones depressed; ridges twelve in number, but probably two or three more exist on each umbo, strong and well marked; interspaces wide, depressed, or perhaps very slightly concave, especially towards the ventral portion of the valves; reticulation not preserved. Length, about three-sixteenths of an inch.

*Obs.* This little fossil, the first *Estheria* found in the Secondary rocks of Queensland, appertains to the group represented by such species as *E. mangaliensis*, *E. Forbesi*, &c., and, in fact is so very close to the former in its general features, that I feel constrained to consider it as identical, notwithstanding the absence of the reticulated surface in our fossil. It is particularly like Prof. Jones' Pl. 2, fig. 16.

The Indian specimens are from the Mangali Beds of the Damuda Series, and the occurrence of the species in the Ipswich Beds is but another link in the chain of evidence uniting the great Secondary Coal-bearing Series of India with those of Australia.

The specimen was obtained, with a magnificent collection of Mesozoic plants, by Mr. J. H. Simmonds from the Ipswich Beds.

*Loc.* Denmark Hill, Ipswich Coal Field (*J. H. Simmonds*—Colln. Simmonds, Brisbane).

Class—**INSECTA.**Order—**COLEOPTERA.**Family—**BUPRESTIDÆ.**

*Genus*—**MESOSTIGMODERA**, Etheridge fil. and Olliff, 1890.

(Mem. Geol. Survey N. S. Wales, Pal. No. 7, p. 9.)

**MESOSTIGMODERA TYPICA**, *E. and O.*

*Mesostigmodera typica*, Etheridge fil. and Olliff, Mem. Geol. Survey N. S. Wales, Pal. No. 7, 1890, p. 9 t. ii., f. 1-3.

*Obs.* A detailed description of this interesting Insect-Wing will be found at the reference quoted above, supplemented by the following remarks:—

"The remarkable character of the ornamentation or sculpture of this wing will at once distinguish it from the various genera of the family Buprestidæ, both recent

\* *Fide* T. R. Jones, Mon. Foss. Estheriæ, 1862, p. 10.

and fossil, and from the allied families Elateridæ and Eucnemidæ; indeed we cannot recall, at this moment, a single genus throughout the whole Coleopterous order in which the ordinary punctate-striate sculpture—consisting of distinct punctures arranged in regular series one behind another—is combined with small irregularly disposed elevations. Its form and structure clearly indicate that it belongs to the Buprestidæ, and there is little doubt, we think, of its affinity to that type of the recent genus *Stigmodera* (e.g., *S. gratiosa*, Chev., *S. Roei*, Hope, &c.), which prevails in Western and South Australia. The type of which we speak is represented in New South Wales by one or two species, and it is to one of these, *S. sanguinosa*, Hope, that the fossil wing appears to be most nearly allied. The peculiar punctuation appears to indicate that this Insect belongs to a very ancient type, and an examination of the specimen suggests the possibility that the ordinary rugose form of sculpture, accompanied by deep pits, now so prevalent amongst the Buprestidæ, may, so far as the Australian species are concerned, have been derived from this older type."

We are indebted to the researches of Mr. J. H. Simmonds for this very interesting fossil. Other Insect remains were found by him at Ipswich, with one exception the remains of Coleoptera. Two well preserved elytra are certainly referable to the Rhynchophora, and one is evidently related to the genus *Glochinorrhinus*, or its immediate allies. Two other fossils, exhibiting the thorax and elytra, are probably representatives of the family Hydrophilidæ, both of them having the wing-cases punctate-striate, &c. A fifth specimen appears to be the head and pro-thoracic segment of a Coleopterous larva, possibly of one of the Lampyridæ, but in the absence of further material, it is not judicious to venture a decided opinion. The only other specimen which has, so far, been found, appears to be the impression of the abdomen of one of the large Hemiptera.

*Loc.* Denmark Hill, Ipswich Coal Field (*J. H. Simmonds*—Colln. Simmonds, Brisbane).

## Sub-Kingdom—MOLLUSCA.

### Section—MOLLUSCA VERA.

#### CLASS—PELECYPODA.

#### Order—UNIONACEÆ.

#### Family—UNIONIDÆ.

#### *Genus—UNIO, Phillipson, 1788.*

(Dissert. Hist. Nat. Nov. Test. Genera, p. 16.)

#### UNIO IPSVICIENSIS, *sp. nov.*, Pl. 42, figs. 2 and 3.

*Sp. Char.* Transversely elongated, narrow, wedge-like, sub-acute posteriorly. Dorsal or cardinal margin short, much less than the length of the shell; ventral margin generally rounded, but straight towards the centre. Anterior end short and rounded; posterior end produced and obtusely pointed. Umbones small, quite anterior, and much eroded. No true posterior slope, but the flanks insensibly graduating into the posterior end. Surface with concentric roughened corrugations.

*Obs.* This species is so generally like many other species of *Unio* that it is difficult to point out its distinctive characters. It is a very much smaller species than the following one, and it is quite distinct from anything yet described from Australian Mesozoic rocks.

*Loc.* Shaft at the Bremer Basin Colliery, at a depth of two hundred feet (*E. Heaviside*).



UNIO EYRENSIS, *Tate*.*Unio Eyrensis*, Tate (m.s.)

„ Etheridge fil., in H. Y. L. Brown's Reports on Coal-bearing Area in the Neighbourhood of Leigh's Creek, S. Austr. (S. Austr. Parl. Papers, 1891), p. 11, t. 2, f. 1-3.

*Sp. Char.* Shell transversely elongate, or elongately subovate, length more than twice the height; anterior end slightly produced, posterior end obtusely pointed, and produced; hinge-line behind the umbones obliquely inclined; ligamental area broad; ventral margin convex; umbones tumid, depressed, and much eroded; anterior muscular impressions low down, the posterior small and close under the hinge-line; shell moderately thick, surface representing the epidermis coarsely striate and subimbricate.

*Obs.* This species is represented by two examples, one an internal cast with portions of the shell still remaining, the other a more complete individual, with nearly the whole of the shell preserved and the umbones eroded. The specimens are converted into ironstone, and their appearance is so different from the other North Queensland fossils as to at once suggest a totally different deposit.

The species of *Unio* hitherto described from Australian rocks are very limited in number, and we have now in consequence to deal with one of an entirely new facies. *U. eyrensis* resembles to some extent the species from the Judith River Group of North America, but is a more convex and bulky form, and devoid of radiating striæ.

*Unio Danæ*, Meek and Hayden,\* from the Laramie Group (Cretaceo-Tertiary), resembles the present species to some extent, but is not so nasiform, or elongately wedge-shaped.

Amongst European Wealden species it is not unlike *U. porrectus*, Sby., but still more like *Unio sub-porrectus*, A. Roemer,† or *U. Dunkeri*, Struckmann.‡

*Loc.* Bundamba, near Ipswich, in brick clay overlying coal (*Hon. A. C. Gregory*, and *J. Malbon Thompson*).

UNIO, *sp. ind.*

*Obs.* A second species occurs in the same bed at the Bremer Colliery, but it is distinct from *U. ipsviciensis*. It is far larger than the latter, and evidently differed much in shape, being a broader and stronger species. The specimen consists of the anterior portion of the conjoined valves, and had lost all trace of shelly matter. It is too imperfect for further diagnosis.

E.

\* White in Powell's 3rd Ann. Report U. S. Geol. Survey, 1881-82 [188 t. 17, f. 1-3

† Dunker, Mon. Norddeutschen Wealdenbildung, 1846, p. 27, t. 11, f. 6.

‡ Die Wealden-Bildungen, 1880, t. 1, f. 6.

## CHAPTER XXXI.

### THE ROLLING DOWNS FORMATION (LOWER CRETACEOUS).

#### ARTESIAN WELLS.

As will be seen by the Geological Map, the "Rolling Downs Formation" covers an area which may be roughly stated at three-fourths of the total extent of the Colony. It extends westwards from the Palæozoic ranges on the east coast, from near the heads of the Macintyre in the south to the Palmer in the north. West of this line it occupies the whole of the Colony, save where it is unconformably overlaid by the Desert Sandstone, and where the Palæozoic rocks of the Cloncurry, and of De Little, Cairn, and the Grey Ranges rise from beneath it like islands. Westward and southward it extends across South Australia into Western Australia and New South Wales. Except in Queensland, however, it appears to be covered to a considerable extent by Tertiary rocks. It marks the position of a sea which in Cretaceous times divided the Australian Continent into two islands.

The Ipswich Coal Field seems to pass upward into the Rolling Downs Formation, although the junction has not yet been satisfactorily traced. To draw a definite line between the Ipswich and the Rolling Downs Formations is quite impracticable, but the appearance of *Belemnites* and *Ammonites*, with other marine forms, in the latter, sufficiently marks the change from the plant-bearing beds of the former.

Everywhere in the North the Rolling Downs Formation lies directly, and of course unconformably, on schists and slates of undetermined age, or on granite or gneiss, the Ipswich Formation being unrepresented. The "Rolling Downs" is by no means a mountain-forming formation. Generally, its decomposition forms a rich soil which is taken possession of by the nutritious "Mitchell" and "Blue" grasses, so highly favourable to the rearing of sheep and cattle. The surface rises into a series of gentle undulations, not, however, of sufficient importance to disturb the idea of a dead level. Travelling over the "Downs" becomes monotonous after a few days, the sun rising in the east and setting in the west on the horizon of an ocean-like plain. The watercourses which intersect it are dry for the greater part of the year, except for a few waterholes, and are so ill-defined that it is hard to tell in dry weather which way the water flows in wet. Each watercourse is marked by a straggling fringe of timber, while the rest of the plains are treeless. As the streams are of this character, it results naturally that they rarely cut through the soil, and consequently sections of the strata occur only at wide intervals.

The monotony of the scenery is the direct result of a sameness of composition throughout the whole series.

In announcing the discovery, in 1867, of a suite of fossils by Mr. W. P. Gordon, in Wollumbilla Creek,\* the late Rev. W. B. Clarke † referred to the "pale sandstones of the creek, and hard red conglomerates and quartzites from between Wollumbilla and the River Amby." [The latter probably Desert Sandstone.] Subsequently Mr. Clarke ‡ stated that the Wollumbilla fossils occurred in rounded, nodular, or concretionary boulders, imbedded in a brittle marl in the creeks, and on the downs, which are covered

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\* Wollumbilla Creek is crossed by the Western Railway, 294 miles from Brisbane.

† Quart. Journ. Geol. Soc., xviii. (1862), p. 245.

‡ Recent Discoveries in Australia, p. 52.

by grits and sandstones, mostly red and evidently partly fused by igneous action [Desert Sandstone]. The calcareous sandstone occurs along the creeks and downs where water has denuded it; and, above all, is a coarse grit. The descending section in the creek bank, where the fossiliferous nodules occur, at Wollumbilla, is as follows:—

1. Brown stiff clay, full of pebbles of quartz, much waterworn.
2. Clay.
3. Slate-coloured marl, very friable above, but hard below, charged with strings of crystalline carbonate of lime, and breaking into rectangular fragments. In this occur the calcareous masses. The height of the section is about fifteen feet. On the east; *at about three miles distance, coarse conglomerates rise above these beds.* The bluff end of the conglomerate rises to about twenty feet. [The conglomerates referred to after the words in italics must be the Desert Sandstone.]

“The calcareous boulders from the Wollumbilla Creek, when broken, are found to be of a deep olive colour internally, a few presenting a dull brown or bluish hue. They are very compact. In all of them organic remains are very abundant. The exteriors of many of the boulders are much waterworn, and exhibit only sections of the organic remains they contain, whilst in others a certain amount of decomposition or oxidation of the surface has taken place, which has produced a rotten exterior, looking like an impure chalk, of a yellow or buff colour. Where this is the case the fossils stand out sharply from the matrix.”

I may observe that I do not agree with the Author as to the waterworn condition of the boulders, which are probably concretionary masses weathering spheroidally.

The Wollumbilla fossils were described and figured by Mr. Charles Moore, F.G.S., in 1869.\* I do not propose to repeat Mr. Clarke's or Mr. Moore's lists, which are incorporated, with annotations, in my Colleague's observations. Mr. Moore's conclusion as to the age of the deposits is as follows:—

“It is not easy to decide with certainty as to the exact position of the fossils that come from Wollumbilla. The Lias, the Great Oolite, the Oxford Clay, the Portland Oolite, and the Cretaceous Beds may each put in a claim; but that of the Oxford Clay appears to be strongest. That they all belong to the Upper Oolite may with safety be inferred.” Of the Bungeworgorai and Amby Beds, in the same neighbourhood, Mr. Moore says, “From the nature of the matrix, though this does not pass for much, they appear to have been derived from beds of a different character from those from the other districts. As similar *Criocerata* have never been found below the Lower Greensand, it is reasonable to infer the presence of Neocomian Beds in Australia, from whence it may have been derived.”

Mr. Daintree mentioned in 1868 † the occurrence of Belemnites on the Dugald River, Cloncurry District.

In accompanying Hann's Northern Exploring Expedition in 1872, Mr. Norman Taylor discovered richly fossiliferous deposits in the Walsh District. From notes which he has kindly placed at my disposal, I make the following extracts:—

“At Camp 11 on the Walsh River, and likewise at Camp 79 (return journey), ‡ at Elizabeth Creek [near what is now Wrotham Park Station], where mostly

\* Quart. Journ. Geol. Soc., xxvi., p. 226.

† Report on the Cape River Diggings, and the latest Mineral Discoveries in Northern Queensland Brisbane: by Authority: 1868.

‡ The positions of the Camps referred to are laid down (Mr. Taylor says not very accurately) on the map attached to Mr. Hann's “Diary of the Northern Expedition.” Brisbane: by Authority: 1873.

*Belemnites* were found in a calcareous conglomerate. In a creek a short distance to the north-east of Camp 81 (return journey), there occur large quantities of ironstone nodules, in one of which I discovered a fine and very perfect crustacean, which, however, appears to have been lost,\* as it was not noticed by Mr. Etheridge, senr., when describing the Collection. The Mesozoic rocks here rest on a grey felsitic quartz-porphry.

"At Camp 11 the Mesozoic beds consist of thin-bedded brown, olive, and whitish concretionary shales, passing downward into blue marly-shales, having a crystalline efflorescence on the surface (sulphate of soda?) and decomposing rapidly. The olive-coloured limestone concretions form lines (in the shales) in the cliffs, like the flints in the chalk of England. These beds dip slightly northwards, and are faulted in several places, and are jointed east and west. To the south the plains are occasionally covered with these boulder-like concretions and glazed ironstone pebbles.†

"At Elizabeth Creek, between Camps 11 and 13, the cliffs consist of red and white conglomerates‡ passing downwards into sandy beds, which rest on blue shales and gypseous marls, with thin layers of gypsum and cone-in-cone limestone. Septaria also occur with veins of dolomite and centres of calc-spar. Irregular patches of red and yellow concretionary ironstone also occur, some pebbles having an external jet-black polish. With the exception of a fragment of an *Orthoceras*,§ the only fossils I could find were *Belemnites* in a calcareous conglomerate at the base of the cliffs and obscured by talus.

"At Camp 14, Mesozoic blue shales and concretionary limestones occupy the river bed, overlaid by a grey jointed calcareous sandstone. The rounded flattened concretions (*not* boulders) in these beds, as well as the beds themselves, contain a rich store of fossils, especially Cephalopoda (*Ammonites*, *Crioceras*, &c.). These fossil beds *are everywhere overlaid* by siliceous pebbly conglomerates, coarse grits and sandstones, and ironstone and ferruginous grits."||

"In a letter from the late Rev. W. B. Clarke to myself, dated 4th June, 1874, he says: "Prof. Etheridge (senr.) says of the Walsh River fossils, 'there is no specimen of *Orthoceras* in the entire series,' and Mr. Carruthers writes thus: 'There is not sufficient to warrant establishing a species, but the fragments point to a form of *Teniopteris*, nearly allied to *Strangerites ensis* (Oldham and Morris in Indian Survey Memoirs), which Schimper calls *Angiopteridium*. We must have more materials, however, before we can be certain.'"

The following is Mr. Etheridge's description of the Walsh River fossils, quoted in a letter of the late Mr. K. T. Staiger, the then Curator of the Queensland Museum, Brisbane, dated 8th May, 1874.

"The Walsh River fossils consist of the following forms:—

#### CEPHALOPODA.

<i>Ammonites</i> , allied to <i>A. clypeiformis</i> .	}	All from nodules.
<i>Ammonites</i> , sp. (?)		
<i>Crioceras</i> (4), sp.		
<i>Belemnites</i> (2), sp.		

\* In a letter to me, dated 25th October, 1879, Mr. Taylor says: "In looking over the list of Queensland Exhibits, at Sydney, I find one by the Trustees of Brisbane Museum of a *Crustacean* unknown, from the Walsh, which must be my missing specimen." (*R.L.J.*) The specimen exists in the Queensland Museum, and will be described. (*R. E. Junr.*)

† Mr. Skene, of Wrotham Park Station, assures me that *Ammonites* and *Belemnites* occur at Elizabeth Creek *in situ*. (*R.L.J.*)

‡ Desert Sandstone, apparently. (*R.L.J.*)

§ Probably the phragmacone of a *Belemnite*. (*R. E. junr.*)

|| Desert Sandstone? (*R.L.J.*)

## BIVALVE SHELLS.

*Myacites*  
*Byssarca*  
*Solemya*  
*Arca*  
*Panopæa*  
*Inoceramus*

*Hinnites*  
*Cytherea*  
*Cyprina*  
*Myoconcha*  
*Pecten*  
*Teredo* in fossil wood.

"I believe the whole of these are Cretaceous (Lower) and one perhaps Neocomian. Most of the species are new, but to figure and describe them would serve no good purpose, as they are all apparently in drift, nodules, and can hardly have been found *in situ*. I shall always have much pleasure in rendering you what assistance I can in these matters, but I would at the same time point out the uselessness of sending home any fossils for determination which are simply drifted surface specimens. The perplexing mixture of forms from Wollumbilla, previously described by Moore, arose from this collection of specimens from drifted nodules. The whole series will be returned to the Colony as soon as Mr. Carruthers has completed his investigation of the supposed specimens of *Glossopteris*."

Mr. Taylor continues:—"No mention is made of some fine *Ichthyosaurus* vertebræ discovered on the Walsh by Warner (one of our party), or of my Crustacean.

"The Mitchell River bed is composed (at Camp 14) of thin grey shales and brittle, conchoidally fractured, marly mudstones, full of large and small flattened globular concretions. The mudstones are full of *Dentalium* (?) and small bivalves (*Leda* ?), and the concretions of large bivalves and Cephalopoda (*Pecten*, *Ammonites*, &c.) always lying on their flat surfaces. That they have been formed *in situ* by segregation of the calcareous matter round the decomposing animal, there can be no doubt. The idea of their drift origin is simply preposterous."

Calcareous nodules, such as are described by Mr. Taylor, are of common occurrence among the shale beds all over the Rolling Downs, and I have no doubt that Mr. Taylor's fossils were found *in situ*. At the same time the misconception on the part of Mr. Etheridge probably arose from the imperfect data concerning the occurrence of the fossils with which he was furnished. As a matter of fact, I am given to understand that the *Ichthyosaurus* vertebræ, from what cause I cannot tell, never reached Mr. Etheridge.

The late Mr. R. Daintree remarked \* that "all the great plains of Queensland westward of the Main Range consist of subærially decomposed Oolitic and Cretaceous shales, limestones, and sandstones;" and, further—"The only variety in the lithological character of the Flinders and Thompson Rivers Mesozoic rocks is the change from shale to fine-grained sandstone in the alternating beds, the shale greatly predominating; its line of bedding marked by thin bands and nodular layers of argillaceous limestone."

"One other peculiarity in the strata forming the series is the presence at intervals of thin layers of limestone having the well-known cone-in-cone structure. This has more the appearance of a chemical precipitate than a mechanical deposit, and contains no fossils. Its analysis gave:—

Insoluble in hydrochloric acid ...	...	...	...	...	...	14.920
Ammonia-precipitate ...	...	...	...	...	...	4.860
Carbonate of lime ...	...	...	...	...	...	75.458
Undetermined constituents ...	...	...	...	...	...	4.762

100.000 "

\* Quart. Journ. Geol. Soc. 1872, xxviii., p. 282.

Speaking of the collection examined by Mr. Moore, Daintree suggests\* that "it is possible that fossils from different localities, or perhaps drift specimens, have been mixed up."

In the same Paper Mr. Daintree (p. 278) remarked that "a single shell (*Tellina*) found in a bed of horizontal limestone at the head of the Gregory on the Barkly Tableland, and forwarded to me by the Rev. W. B. Clarke, of Sydney, would, if belonging to this Desert Sandstone [Series], as it probably does, give reason to believe that the lacustrine condition may be eliminated." This observation is noticed merely for the purpose of correcting Daintree's mistake, the limestone of the Barkly Tableland having since proved to belong to the Rolling Downs Formation.

Daintree continues as follows:—"As early as 1866, a suite of fossils was collected by Messrs. Sutherland and Carson (of Marathon Station) on the Flinders River, and forwarded for determination to Prof. McCoy in Melbourne. They were never figured †; but his manuscript names are as follows ‡:—

#### REPTILIA.

*Ichthyosaurus australis*, McCoy.  
*Plesiosaurus Sutherlandi*, McCoy.  
*Plesiosaurus macrospondylus*, McCoy.

#### CEPHALOPODA.

*Ammonites Sutherlandi*, McCoy.  
*A. Flindersi*, McCoy.  
*Belemnitella diptycha*, McCoy [= *B. Canhami*, Tate].  
*Ancylloceras Flindersi*, McCoy.

#### LAMELLIBRANCHIATA.

*Inoceramus Carsoni*, McCoy.  
 „ *Sutherlandi*, McCoy.

"One locality being assigned to all the fossils alluded to in the above notice, it was evident to me that either fossils from different localities had been mixed together, or derived specimens had been mingled with those obtained *in situ*, and no satisfactory conclusion or inference could be drawn, for purposes of correlation with European, Asiatic, or African forms. In company with Mr. Sutherland, who supplied McCoy with the before-mentioned materials, I therefore visited the Upper Flinders and carefully collected the fossils from three localities—viz., Marathon Station, Hughenden Station, and Hughenden Cattle Station.

"At Marathon, which is some forty miles further down the Flinders than Hughenden, there is, close to the homestead, an outcrop of fine-grained yellow sand-

\* *Loc. cit.* p. 282.

† Prof. (now Sir. F.) McCoy published his researches on these fossils in a series of Papers entitled as follows:—

- (1.) A Note on the Cretaceous Deposits of Australia. *Ann. and Mag. Nat. Hist.*, 1865, 3rd Ser., xvi., p. 333.
- (2.) On the Discovery of Cretaceous Fossils in Australia. *Trans. R. Soc. Vict.*, 1866, vii., pp. 49-51.
- (3.) On the Occurrence of *Ichthyosaurus* and *Plesiosaurus* in Australia. *Ann. and Mag. Nat. Hist.*, 1867, 3rd Ser., xix., p. 355.
- (4.) On the Discovery of *Erialosauria* and other Cretaceous Fossils in Australia. *Trans. R. Soc. Vict.*, 1868, viii., p. 41.

From these references, it will be seen that Sir F. McCoy was absolutely the first to announce the occurrence of Cretaceous fossils in Australia.

‡ Without the attached notes.

stone, which has been quarried for building purposes; and below this, down to the edge of a waterhole supplying the house, is a series of sandstones and argillaceous limestones, containing numerous organic remains.

"These I have submitted to Mr. Etheridge [Senr.], for examination and correlation, the result of which will appear in the Appendix to my paper; I, however, attach here a summary of the forms determined by him from this locality:—

*Inoceramus marathonensis*, Eth.\*

" allied to *problematicus*.

" *pernoides*, Eth.

" *multiplicatus*, Stol., var. *elongatus*, Eth.

"From these beds also came McCoy's Reptilia.

"The 'Marathon' Beds, as they may be designated, are undulating, with an uncertain dip. Proceeding from 'Marathon' up the Flinders River (most probably over a series of older beds) no cliff-sections are met with; but at Stewart's wash-pool, on the main road, the *Avicula hughendenensis*, Eth. [= *Aucella hughendenensis*, Eth. fil.] of Hughenden is found in abundance.

"At Robert Grey's Hughenden Station, however, which lies about three miles east of Mount Walker, a series of calcareo-argillaceous beds crop out, containing a marked and well-preserved fauna, indicating no great difference in *facies* from that of Marathon."

A section accompanying Daintree's text "of a cliff on Bett's Creek, intermediate between Marathon and Hughenden," and another "on the bank of the Flinders," "show how nearly horizontal the great Mesozoic system of the Flinders remains; but the latter indicates their general dip towards the north-east [north-west must be meant], and therefore places the Hughenden Beds below those of Marathon. The observations collected on the journey between these two places give the same result. The palæontological evidence is not sufficient to enable Mr. Etheridge [Senr.] to draw any great line of demarcation. His determination of the species from the Hughenden beds is as follows:—

*Ammonites Beudanti*, D'Orb, var. *Mitchellii*, Eth.

" *Daintreei*, Eth.

*Avicula hughendenensis*, Eth.

*Pecten*, &c.

"These were obtained from horizontal calcareo-argillaceous beds, fronting the water-hole where the sheep-wash is placed, about half a mile from the Hughenden Station. The *Avicula* bed, which is a very marked band, about four inches thick, gives by analysis:—

Residue insoluble in HCl, chiefly clay ... ..	17.230
Ammonia-precipitate, of which 1.219 per cent. was ferric-oxide ...	9.368
Carbonate of lime... ..	67.888
Carbonate of magnesia ... ..	2.520
Undetermined, water, &c. ... ..	2.994

100.000

"The Hughenden Cattle-station is twenty miles further up the Flinders than the Hughenden Head Station. Here hundreds of *Belemnites* are strewn over the surface of the two ridges which front the Cattle-station huts, but they are rarely found in the soft shales which crop out from under an escarpment of 'Desert Sandstone.'

\*The names quoted here must be understood to be subordinate to those hereafter given by my Colleague.

"The lithological character of these Cretaceous strata is such that decomposition is rapid; and cliff-sections are accordingly very rare, the resulting physical aspect being that of vast plains, which form the principal feature of Queensland scenery west of the main dividing range; but that the 'Desert Sandstone' has extended over all this country is evidenced by its existence either in the form of outliers or as a marked feature *in situ* on all main watersheds, or by its pebbles of quartz and conglomerate, which are strewn everywhere over the surface of the plains.

"The height of the watershed between the Thompson and the Flinders Rivers is locally not more than 1,400 feet above sea-level; and as the former river has to travel as many miles before reaching the sea, it is easy to understand why, in a country subject to heavy tropical rains at one period of the year, followed by a long dry season, the river channels are ill-defined, and vast tracts of country covered by alluvial deposits."

Mr. Robert Etheridge, F.R.S., in an Appendix to Mr. Daintree's Paper, gave a detailed description of the fossils from the Flinders area, which need not here be repeated, as in the following pages the names and descriptions are recapitulated, with annotations and the results of a fuller experience, by my Colleague.

Speaking of the material which formed the subject of Mr. Moore's paper already referred to, Mr. Etheridge says \* :—"It is, however, to be regretted that his specimens were not obtained *in situ*, instead of from drifted materials; for nothing is known of the beds or sections from which the Wollumbilla fossils originally came. It is not a little singular, however, that Mr. Moore recognised twenty species as common to England and Western Australia." In this, and the same Writer's remarks on Mr. Taylor's Walsh fossils, as well as in Mr. Daintree's remarks, we can trace the steady growth of the misconception which I believe was started by the Rev. W. B. Clarke's error in taking the Wollumbilla nodules for drifted boulders.

From the imperfect materials at his disposal, and taking his stratigraphical information, it must be remembered, at second-hand, Mr. Etheridge read the sequence of the Mesozoic and Cainozoic strata, as follows :—

		Cainozoic	{ Pleistocene. Upper Volcanic. Desert Sandstone. Lower Volcanic.
	Mesozoic.	{ Cretaceous	{ Marathon Beds. Hughenden Beds. Maryborough Beds.
		{ Oolitic	{ <i>Taniopteris</i> [Tivoli and Burrum Coal Measures]. Wollumbilla Beds. Lias and Oolite. Gordon Downs Beds.†

I may say here that later stratigraphical observations show, and palæontological research corroborates, that the Burrum Coal Field is older than the Ipswich (represented by Tivoli in the above list); that I regard the Hughenden, Marathon, and Wollumbilla Beds as practically on the same horizon and of Lower Cretaceous age; and that the Desert Sandstone and Maryborough Beds are identical and Upper Cretaceous.

Sir Richard Owen describes ‡ under the name of *Notochelys costata*, Owen, § a Chelonian reptile from the Flinders River.

\* *Loc. cit.*, p. 323.

† Gordon Downs, near Roma, the locality referred to, must not be confounded with Gordon Downs at the head of the Roper, near Clermont, where Permo-Carboniferous Coal Measures occur.

‡ *Quart. Journ. Geol. Soc.*, Vol. xxxviii., p. 178.

§ Hereinafter described as *Notochelone costata*, Owen, sp. (*R. E. Junr.*)



The Rev. T. W. Ramm, in 1885, presented to the Geological Survey Collection, a Cephalopod from the Flinders River, near Hughenden, which I took for *Orthoceras*, but which my Colleague now identifies with *Belemnites Selheimi*, Ten. Woods.

The extracts above quoted appear to exhaust the stratigraphical and lithological information recorded by former writers on the Rolling Downs Formation, and I now add what I have myself observed in various traverses of the Western District.

From the junction of Julia Creek with the Cloncurry north-westward to Gregory Downs, the strata of the Rolling Downs Formation can be traced.

At Kamilaroy, on the Leichhardt River, and the "Grass Gunyah," twelve miles south-west of Kamilaroy, are extensive outcrops of magnesian limestone. At Kamilaroy the limestone yielded specimens, among which my Colleague recognised *Belemnites*; *Otodus apendiculatus*, Agassiz; vertebræ of a Teleostean fish; and a posterior costal plate of a Chelonian.

On the Leichhardt, nine miles from the mouth of Gunpowder Creek, another limestone yielded *Belemnites*, a portion of the tooth of *Lamna*, and *Aucella hughendenensis*, Eth.

Running up the Gregory River, Palæozoic rocks occupy the greater part of the distance from Gregory Downs to the mouth of the O'Shanassy. Carl Creek Police Station is situated on the right bank of Carl Creek, a fine rushing stream, which leaves the Gregory and runs into the O'Shanassy. Behind the barracks is a large open plain bounded on the south by cliffs of a hard yellow limestone, horizontally bedded. This limestone evidently occupies an ancient depression, and overlies (unconformably) nearly vertical Palæozoic sandstones, &c. The summit of this limestone forms a plateau which extends to Rocklands under the name of Barkly's Table-land. The occurrence of *Tellina* on Barkly's Table-land has already been noted.

On the Upper Flinders, eighteen miles N. 29° W. of Coalbrook Railway Station, on the Northern Railway, the Rolling Downs Formation is seen beneath the Desert Sandstone. The uppermost beds seen are soft crumbling dark-grey shales, about sixty feet in thickness, with bands of red ferruginous sandstone or arenaceous ironstone and grey limestone. Thence, down to the level of the river, are seen about ten feet of dark, fine-grained, felspathic sandstone. The surfaces of the sandstone beds in the river are in places covered with obscure markings suggestive of the tracks of gigantic reptiles. The beds of the Rolling Downs Formation seen in this section, although nearly horizontal, undulate slightly, but their general tendency is to dip down the river, while the Desert Sandstone remains horizontal, thus affording a new instance of the unconformability observed elsewhere between the two formations. The shaly beds of the inferior formation, with their bands of ironstone and limestone, bear a close resemblance to the portion of the Rolling Downs Formation exposed in the neighbourhood of Hughenden. A few hundred yards up the river, the rise of the strata exposes beds on a lower horizon than those above described. These are thick-bedded sandstones, partly of felspathic but mainly of siliceous materials, varying into grits, pebbly grits, and conglomerates. About two miles further up the river the following section is seen on the left bank:—

Section No. 1.

						Ft.	in.
(a)	White gritty and pebbly sandstone	...	...	...	...	40	0
(b)	Laminated grey micaceous clay	...	...	...	...	0	9
(c)	Coal	...	...	...	...	0	2½
(d)	Fine-grained brown siliceous shales, with plant-remains	...	...	...	...	0	2

											Ft.	in.
(e)	{	Coal ... ..	...	...	...	...	...	...	...	...	0	6
		Brown laminated clay	...	...	...	...	...	...	...	0 to	0	1
		Coal ... ..	...	...	...	...	...	...	...	...	0	7
(f)	{	Black mud with coaly streaks	...	...	...	...	...	...	...	...	0	3
		Grey-brown shale, with coaly specks and streaks	...	...	...	...	...	...	...	...	1	0
		Coal ... ..	...	...	...	...	...	...	...	...	0	0½
(g)	{	Grey shales with coaly streaks	...	...	...	...	...	...	...	...	1	6
		Coal in bed of river (bottom of seam not seen)...	...	...	...	...	...	...	...	...	0	6

On the right bank of the river, about one chain below the last section (south-south-west), the following section was measured :—

*Section No. 2.*

											Ft.	in.
(a)		Sandstone	...	...	...	...	...	...	...	...	40	0
(b)		Laminated grey micaceous clay or shale	...	...	...	...	...	...	...	...	0	8
(c)		Coal	...	...	...	...	...	...	...	...	0	2
(d)		Fine-grained brown siliceous shales, with plant-remains	...	...	...	...	...	...	...	...	0	2½
(e)		Coal	...	...	...	...	...	...	...	...	1	1
(f)		Dark-grey shale or fire-clay, with plant-remains	...	...	...	...	...	...	...	...	0	2½
(g)		Coal in bed of river (bottom not seen)	...	...	...	...	...	...	...	...	0	7

On the left bank of the river, about three chains above Section No. 1, the following section was seen :—

*Section No. 3.*

											Ft.	in.
(g)	{	Coal ... ..	...	...	...	...	...	...	...	...	1	1
		Dark sandstone band	...	...	...	...	...	...	...	...	0	1½
		Coal ... ..	...	...	...	...	...	...	...	...	0	2
		Brown hard unlaminated siliceous clay, with coaly streaks, in bed of river (bottom not seen) ... ..									0	8

In the above three sections, the identifiable beds are distinguished by italic letters.

An analysis of a sample of seam (g) gave the following results :—

Water	...	...	...	...	...	...	...	...	8.30
Volatile hydrocarbons	...	...	...	...	...	...	...	...	37.36
Fixed carbon	...	...	...	...	...	...	...	...	51.04
Ash	...	...	...	...	...	...	...	...	2.80

100.00

Specific gravity 1.38.

The coal scarcely soils the fingers, and gives a jet-black powder. The ash is white, with a faint yellow tinge, and mainly siliceous. The coke is hard and firm. The small amount of incombustible residue, and the proportions of volatile hydrocarbons, and fixed carbon, make this coal a very valuable one, either for gas-making or steaming purposes; in fact, it may be pronounced to be a better coal than some of the most highly prized coals of Newcastle (N.S.W.). The thickness of the overlying Desert Sandstone is not great, and may place no very serious difficulty in tracing the coal-seams, should any be found of workable thickness, to the railway line.\*

In the Diagram (Pl. 45, fig. 1) the relation of the Rolling Downs Formation to the granite and other rocks, as seen at Tatoo Camp, in a gully near the head of the

\* Report by R.L.J. on Coal Discoveries on the Flinders. Brisbane: by Authority: 1888.

Flinders, is well shown. It rests on the granite, and is overlaid unconformably by the Desert Sandstone, which overlaps it, and abuts against the granite. The Desert Sandstone itself is covered by lava-form basalt beds which overlap it and appear again in great force on the Burdekin side of the granite range. The altitude of Tatoo Camp was estimated (by Aneroid) at 1,840 feet.

On the Dalrymple Road, twelve miles above Hughenden, a gully, rising in Mount Beckford, and falling into Porcupine Creek, exposes a section of about twelve feet of horizontally bedded grey clay shales, with thin bands of grey flags and "damper-shaped" nodules of magnesian limestone, each enclosed in an envelope of glittering carbonate of lime. Exactly similar strata are exposed at Hughenden Township, in the Chinaman's Gully, and at the washpool from which Daintree obtained some of his fossils. I could see, however, only a few *Belemnites*, and some shells, all in bad preservation. The "damper-shaped nodules" are, I believe similar to those from which the Wollumbilla and Walsh fossils were obtained.

I have within the last year or two received several fine specimens of *Crioceras*, some in nodules, from Hughenden Township, and in July, 1891, visited the locality a second time. On this occasion I was more successful than on the former, having split up many of the "damper-shaped" nodules, each of which was found to contain a *Crioceras* or other fossil or fossils. There can be no doubt that the nodules are merely concretions occurring in lines along the bedding-planes.

Mr. George Sweet, of Brunswick, Melbourne, made a collection of fossils from Hughenden in 1889, which have not yet, however, been described.\*

The Rolling Downs Formation occupies the district traversed by the Cloncurry Road from Wongalee, above Hughenden, to Fisher's Creek, near Cloncurry.

Eight miles below Hughenden, I saw some oval nodules of limestone, one of which, on being split up, was found to be full of fragmentary shells.

Between fifteen and thirty-nine miles west of Hughenden, frequent outcrops were seen of nodular calcareous sandstone (which had for the most part, when weathered, lost its lime) and of flaggy, fine-grained, pale-brown, tough sandstone.

Thirty-nine miles below Hughenden, a gully falling into the left bank of the Flinders exposes horizontal beds of brown sandstones, with *Belemnites* and small shells, which, however, were not in preservable condition.

Seven miles above Marathon Station, a limestone bed yielded *Aucella hughendenensis*, Eth., *Inoceramus pernoides*, Eth., and the wing of a Neuropterous insect, *Æschna flindersensis*, Woodward.† One bed of limestone was entirely made up of fragments of *Inoceramus*.

At Marathon Station I saw the beds of fine-grained buff-yellow sandstone, shales, and limestone referred to by Daintree as the source of his fossils, but in the time I could spare (I was hurrying to join the Transcontinental Railway Expedition under General Feilding, at Cloncurry, in the year 1881) I could find no fossils well enough preserved to take away, but I saw numerous fragments of *Inoceramus*.

Seven miles below Marathon Station I obtained specimens of *Inoceramus* (of the remains of which one bed was entirely composed) from buff-coloured and reddish calcareous sandstones.

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\* This Collection has now been partially examined (May, 1892), and a few of the results are incorporated in subsequent pages of this work. The whole will be subsequently described with other material officially collected in the meantime. (R. E. Junr.)

† On the Wing of a Neuropterous Insect from the Cretaceous Limestone of Flinders River, North Queensland. By Henry Woodward, L.L.D., F.R.S., *Geol. Mag.* (1884), vol. i., p. 337.

Twenty-five miles below Marathon Station the road began to be strewn with "cone-in-cone" limestone, evidently derived from beds *in situ* beneath, and from one to four inches in thickness. About a mile further I saw fine-grained yellow sandstones and grey shales dipping at 7° to the S.E.

Three miles above Richmond Downs I observed the following section:—

	ft.	in.
Shales, say ... ..	4	0
Soft grey and yellow sandstone ... ..	2	0
Limestone ... ..	0	6

The bottom of the limestone had a cone-in-cone structure, and the top was full of shells, which my Colleague named *Inoceramus Carsoni*, McCoy, *I. Sutherlandi*, McCoy, and *Inoceramus*, a third species. Daintree's observation, already quoted, that the cone-in-cone limestone contains no fossils, and has the appearance of a chemical precipitate rather than that of a mechanical deposit, will be remembered. I saw an *Inoceramus* quite a foot in length, but was unable to detach it from the matrix.

Between Richmond Downs Station and the Flinders, yellow sandstones having a slight dip to the south-east were observed. In similar sandstone below the stockyard I found an *Inoceramus*. Near the Richmond Downs Post Office I saw a fragment of an immense *Orioceras* lying on the roadside.

Thirteen and a-half miles below Richmond Downs Station a gully falling into the left bank of the Flinders exposed a section of crumbling grey and bluish shales with limestone and grey calcareous sandstone. From these I obtained specimens of *Inoceramus Carsoni*, McCoy.

Twenty-one and a-half miles below Richmond Downs Station, a gully on the left bank of the river showed a scarp of about twenty feet of brown shales, overlaid by grey sandstones, with an apparent dip (though undulating) up the river. From the shales I obtained *Inoceramus Sutherlandi*, McCoy.

Eight miles further the bed and banks of the Flinders expose a series of blue-grey shales and thin-bedded and flaggy soft fine-grained blue-grey sandstone, dipping about 3° to the E. In the sandstone I saw only a fragment of a large flat bivalve.

At the crossing of Neelia Creek I found *Aucella hughendenensis*, Eth., and *Inoceramus* in a bed of limestone. Brown sandstone and cone-in-cone limestone are seen at the crossing.

For sixteen miles beyond Neelia Creek the road is covered with loose blocks of grey sandstone and cone-in-cone limestone. *Belemnites* are occasionally seen on the surface. On some ridges sixteen miles from Neelia Creek, I saw sandstone and cone-in-cone limestone dipping slightly to the east.

Between Neelia and Julia Creeks, grey and brown sandstone and cone-in-cone limestone are frequently seen. At Julia Creek I found the Gasteropod named *Natica Jackii*, Eth. fil., and a fragment of a Cephalopod.

Sections of brown flaggy sandstone and cone-in-cone limestone are exposed by Box Creek.

One mile west of the Williams River is an outcrop of semi-vitreous sandstone containing *Belemnites* and nodules of limestone resembling "curling stones" in size and shape.

Eight miles beyond the Williams are blocks of a very hard brecciated siliceo-calcareous stratified rock, from which I obtained *Inoceramus*. Portions of the rock were almost entirely made up of the disintegrated shelly fibres of this genus. I also observed in one piece the impression of a *Belemnite*.

Fifteen miles from the Williams (on Fisher's Creek waters), sandstones composed almost entirely of the fibrous shelly matter of *Inoceramus* are seen to rest on hardened black slates and Lydian stone. Indeed, in several places, notably near Marathon, I noted the presence of beds almost entirely composed of this fibrous material, sufficient to attest that this mollusc must have lived in almost incredible numbers.

I believe the strata above described, from Wongalee to Fisher's Creek, near Cloncurry, to form one continuous series. They seem to form a large synclinal trough, with an axis crossing the Flinders from east to west, somewhere in the neighbourhood of Marathon. At the heads of the Flinders the lowest beds do not crop out, as the Rolling Downs Formation there overlaps the Palæozoic and Metamorphic rocks of the Dividing Range, and are covered by the Desert Sandstone and the basalts of the tableland. To the west of Richmond Downs, however, a gentle rise to the west brings up a series of strata which apparently occupy a lower horizon than those in the centre of the trough. From Hughenden to Marathon the strata consist for the most part of grey shales with nodules of magnesian limestone and grey and brown sandstones, which are occasionally calcareous and nodular. Near Richmond Downs, where an easterly dip is, for the first time, distinctly observable, the limestones assume a different character, and are distinguished by a prevalent cone-in-cone structure. Further west there are fewer shale beds and thicker and browner sandstones. The latter are extensively veined with gypsum, and I have been informed by squatters and others that beds of gypsum are frequently met with in sinking wells. The whole series is fossiliferous.\*

A bed of gypsum, of workable thickness, and of great purity, occurs at Chollarton, near Collingwood. Specimens of this have been presented to the Geological Survey Collection by Mr. Julius von Berger.

The return journey from the Transcontinental Railway Expedition, from Cloncurry to Charters Towers, *via* Cloncurry, Winton, and Rockwood (1881-2), afforded me opportunities of observing the Rolling Downs Formation on a course to the south of that of the outward journey.

From Edington Station to the head of Eastern Creek scarcely a section of the strata was seen, although the shale *débris* and the marked features of the Rolling Downs sufficiently attested the presence of the formation to which they give their name. The divide between the Gulf waters and those of the Great Australian Bight (Diamantina River?) was crossed imperceptibly, as it forms no "range" whatever.

One and a-half miles down the Diamantina, from Kynooona Station, some grey and buff sandstones, cone-in-cone limestone, and grey shales were observed. The sandstones contained *Echinus* spines.

For the next twenty-five miles down the river, wherever the rock was visible it was found to be of grey or buff sandstone. Sometimes the ground was strewn with large, not well-rounded pebbles of tough quartzite, occasionally inclining to opalization, and smaller and better-rounded pebbles of sandy-brown ironstone. These pebbles are probably derived from the Desert Sandstone, cliffs of which are seen to the south.

For six miles up and five down the river, from Dagworth Old Station, sandstones with grey sandy shales prevail, and the sandstones get coarser in grain and grayer in colour as the river is followed down. A good deal of silicified wood is seen on the surface; but it is doubtful whether it came from the Rolling Downs Formation, or from the Desert Sandstone, which must have covered it.

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\* Report by R. L. Jack on the Geological Features of part of the District to be traversed by the proposed Transcontinental Railway. Brisbane: by Authority: 1885. Supplemented by Notes made on the Journey and hitherto unpublished.

Between the Diamantina and Wokingham Creek, grey sandstones are seen at intervals, with occasional sandy ironstone or ironmasked sandstone. Silicified wood is strewn over the soil.

On Watts' Creek, a tributary of the Diamantina, pale greenish-grey sandstones are seen in thick beds. The sandstone has a remarkable internal structure. Although the lines of bedding continue without interruption, a concretionary process acting on the protoxide of iron in the rock appears to have hardened spherical portions of the mass, which can easily be detached from the softer portions. These spheres weather out, as round as cannon-balls, and can be seen in the bed of the creek, of all sizes, from that of small shot to six feet in diameter. I have so frequently heard descriptions of similar "sandstone balls" from different portions of the Rolling Downs, that the structure referred to cannot be uncommon, but the above is the only instance I have seen. The "balls" are not waterworn, it must be remembered, but concretionary.

In a well sunk, about 1878, on the march between Werna and Ayrshire Downs Runs, a three to four inch seam of coal was cut at one hundred and forty feet; a second seam was struck between one hundred and forty feet and one hundred and eighty feet. The sinking was left off in hard fine-grained sandstone at two hundred and four feet. I was informed that the strata passed through were, with the exception of the coal-seams, all grey sandstones and sandy shales, and that among the beds cut through were an argillaceous flagstone with shells and several beds of sandstone with iron pyrites, and that many fragments of silicified and carbonised wood were met with. Some fragments of coal from the spoil-heap gave, on an approximate analysis:—

Carbon	...	...	...	...	...	...	...	...	39.07
Volatile	...	...	...	...	...	...	...	...	55.96
Ash	...	...	...	...	...	...	...	...	4.97
									100.00

This coal does not soil the fingers, and bears a close resemblance in composition to the famous Lesmahagow Cannel Coal, although it is brighter and more lustrous in cross fracture. My samples had lain exposed to the weather for two and a-half years, and must have lost some of their volatile matter. An analysis of the Lesmahagow Coal is given for comparison:—

Carbon	...	...	...	...	...	...	...	...	39.40
Volatile	...	...	...	...	...	...	...	...	56.60
Ash	...	...	...	...	...	...	...	...	4.00
									100.00

A little water was struck below the first coal-seam, and a little at one hundred and eighty feet. Water stood at one hundred and thirty-four feet from the surface.

In the Township of Winton, "Sheppard's Well" was sunk in Allotment 7 of Section 1. Mr. Julius von Berger supplied me, in 1882, with the following section:—

	Ft.	in.
Alluvial layer (yellowish, sandy, with a few seams of carbonaceous ash)	40	0
Coaly shale	0	0½
Second alluvial layer	40	0
Coal-seam	0	7
Third alluvial layer (compact clay-shale with pieces of jet and lanceolate leaves: in the middle of the layer a bed of shells)	40	0
Coal-seam	2	0
Hard alluvial clay	13	0

No water was obtained in the well. The following analysis of some of the coal fragments from the spoil-heap was made on my return to Townsville:—

Carbon	...	...	...	...	...	...	...	...	...	30.32
Volatile	...	...	...	...	...	...	...	...	...	49.34
Ash	...	...	...	...	...	...	...	...	...	20.34
										100.00

Another well was sunk by the Government, just behind the Court House in Winton, but owing to the recent sudden death of the contractor I could get no information as to the strata passed through. I found (2nd January, 1882) that the greater part of the shaft was slabbed up, but I was informed that a coal-seam fifteen inches in thickness was cut at seventy feet, and another at about one hundred feet. At the bottom of the shaft (one hundred and fifty feet), where it was still unslabbed, I saw horizontally bedded sandy shales. The coal-seams were fifteen and twenty-four inches in thickness respectively. That is, I came to that conclusion, for the accounts I got differed considerably. Opinions would naturally differ as to how much was coal and how much shale. From the fragments I picked up in the spoil-heap, I should say that the coal occurred in thin layers among dark carbonaceous shales. Specimens I analysed at Townsville gave—

Carbon	...	...	...	...	...	...	...	...	...	52.49
Volatile	...	...	...	...	...	...	...	...	...	42.93
Ash	...	...	...	...	...	...	...	...	...	4.68
										100.00

Two species of the genus *Unio* from this well were presented to the Geological Survey Museum by Mr. Julius von Berger.\*

On Vindex Station, near Winton, a well was sunk about 1880. As the station had changed hands between that time and the date of my visit (3rd January, 1882), I could get little information, but I learned that a nine-inch coal-seam was cut at seventy-five feet, and other two seams (the upper one sixteen inches thick) between seventy-five and one hundred feet. At one hundred and ten feet a sufficient supply of water (which rose twenty-five feet) was struck, and the sinking was stopped. The rubbish round the well consisted of soft grey shales and flags, with chips of coal, and a few lumps of hard buff-coloured sandstone.

A second well was sunk on Crawford's Creek, nine miles east of Vindex, and water was obtained at one hundred and fifty feet. The strata passed through were very much the same as in the well at the station. I heard that coal had been passed through, but could get no reliable information.

A twelve-inch bore was being sunk by Mr. F. de Kock on Vindex Run, about seven miles N. 15° E. of the station. I had previously seen, in Mr. von Berger's hands in Winton, samples of some of the strata labelled according to their depths. Mr. de Kock supplied me with the latest particulars of the boring:—

	Feet.
Surface	5
Fine-grained, soft, friable, buff-coloured sandstone	45
Loose ground	10
Yellowish sandstone, hard and fine-grained, with silicified wood below	7
Loose ground	17

\* A deposit of *Unio* has been met with by Prof. R. Tate in the Lake Eyre Basin, South Australia. The specimens have been examined by my Colleague.





On the Nive River, at the Royal Hotel, grey shales with indistinct plant-remains, accompanied by greyish-green sandstone and cone-in-cone limestone, dip to S. at about  $1^{\circ}$ .

In the neighbourhood of Tambo the country forms extensive "downs," with here and there blocks of sandstone, soft and not very coarse-grained, yellow near the outside and green in the interior. The sandstone is pierced with round holes at right angles to the bedding-planes. The holes occur too sporadically and are too deep to be rain-drops. The sandstone has, apparently, all been calcareous, and occasionally has films of half-an-inch to three inches of cone-in-cone limestone adhering to it.

Nine miles down the Barcoo River from Tambo, a calcareous sandstone was observed, crammed with *Belemnites* and other fossils, including *Trigonia*. An exactly similar rock was seen four miles further down the river.

Six miles below the Northampton Hotel, on the Barcoo, a stony ridge on the right bank of the river contained large and small round and roundish nodules of limestone. In the centre of each of the smaller nodules is a shell, while the interiors of the large nodules are, for the most part, shapeless masses of red iron ochre. The shells are mainly *Aucella hughendenensis*, Eth.

Five miles below Northampton Downs Station, a white limestone is seen on a small hill-top. In a gully on the west side of the hill is a section of grey shales and brown sandstones underlying the limestone of the hill-top. These strata have a slight dip to east-north-east. The sandstone contains a few shells.

At Blackall, the town well, two hundred and fifty feet deep and unsuccessful, passed through grey-green flaggy sandstone, a bed of cone-in-cone limestone, and grey shales, containing bivalve shells and *Belemnites*. The bivalves have their shelly matter converted into carbonate of lime, and crumble very readily.

Between Blackall and Aramac, seven miles from Skeleton Creek (in "Recovered South" Block), brown sandstones dip at  $5^{\circ}$  to S.

Two miles beyond Home Creek Station a cone-in-cone limestone is met with.

At Coreena Wool-shed, twenty-one miles north of Saltern Creek, a drab-coloured limestone yielded numerous examples of *Aucella hughendenensis*, Eth.

At Aramac, a well had been sunk to the depth of three hundred feet by the Divisional Board. From specimens preserved by Mr. S. Sharwood, and the information that gentleman afforded me, I constructed the following section:—

- At 22 feet.—Yellow clay shale.
- „ 30 feet.—Yellow clay shale more sandy.
- „ 36 feet.—Two veins of gypsum.
- „ 45 feet.—Alternate shale and fine sandstone.
- „ 47 feet.—Fine-grained permeable sandstone, felspathic, siliceous, and micaceous.  
*Salt water in this.*
- „ 60 feet.—Clay shale, black films of plant-impressions and impressions of shells.
- „ 70 feet.—Clay shales with shells and pyrites concretions.
- „ 78 feet.—Clay shales, a little sandy.
- „ 83 feet.—Clay shale.
- „ 90 feet.—Clay shale.
- „ 110 feet.—Clay shale and a concretion, in part calcareous.
- „ 112 feet.—Clay shale.
- „ 128 feet.—Clay shale.
- „ 132 feet.—Clay shales with shells (unaltered) and pyrites.
- „ 150 feet.—Sandy clay shales.
- „ 153 feet.—Sandy clay shales.
- „ 176-8 feet.—Sandy clay shales, and a calcareous sandstone nodule.

- At 212 feet.—Clay shales with shells and a limestone nodule.
- \* At 224 feet.—Grey fine-grained sandstone with *Ancyloceras Flindersi*, McCoy.
- „ 232 feet.—Clay shales.
- „ 235 feet.—Clay shales with shells.
- \* At 238 feet.—Clay shales with *Inoceramus Crispii*, Mantell?, *Belemnites Canhami*, Tate, and *Ancyloceras Flindersi*, McCoy.
- \* At 244 feet.—Clay shales with *Inoceramus Crispii*, Mantell?, *Aucella hughendenensis*, Eth., *Nucula quadrata*, Eth., and *Nucula*, *sp. ind.*
- \* At 284 feet.—Limestone nodule with *Crioceras*, *sp. ind.*
- \* At 290 feet.—Clay shale with *Ammonites Flindersi*, McCoy.

The fossils to which an asterisk (\*) is attached were presented to the Geological Survey Museum by Mr. Sharwood, and identified by my Colleague.

The reluctance to admit that the Wollumbilla fossils had really been found *in situ*, and the refusal to take into consideration Mr. N. Taylor's Walsh fossils, on the ground that they occurred in drifted boulders (whereas they occurred in concretionary nodules), resulted naturally enough from the presence of an assemblage of fossils such as in Europe could not have occurred in any one formation. It is remarkable that almost every Palæontologist who has worked hitherto on Queensland materials has come to the conclusion that fossils from different localities have been mixed up, and this explanation has appeared to be specially necessary in the case of fossils from the Rolling Downs. On the other hand, my own explorations have satisfied me that Queensland fossils are not more liable to this kind of accident than those of other countries; that the mixing-up which has caused so much annoyance to Palæontologists has been perpetrated by Nature herself; that we have a continuous series of beds of enormous thickness, in which, however, from the scarcity of sections, it would be impossible to map out "horizons"; and that the fossils of the Rolling Downs, from the Gulf to the New South Wales Boundary,\* must be treated as a whole. Shading gradually upwards from the plant-bearing Ipswich Beds, the Rolling Downs Formation contains a marine (and occasionally freshwater) fauna, representing the migration of many species which in Europe date from Rhaetic to Cretaceous, but which cannot be quoted as arguing a strict contemporaneity of life.

Although mainly a marine deposit, plant-beds and coal-seams, indicating fresh water or terrestrial conditions, are by no means rare. At one time I indulged the hope of being able to separate a Lower, or Marine, from an Upper, or Freshwater Series,† but later experience has convinced me that this is impracticable, plant-beds and coal-seams being met with at different horizons, and not being identifiable over large areas. It may be said that I have not myself seen a single plant in the Rolling Downs in determinable condition, the shales on which they are imprinted crumbling rapidly on exposure. The Hon. A. C. Gregory, however, mentions‡ that many well-preserved specimens of ferns, including *Teniopteris* and *Pecopteris*, were found in an ironstone bed in Bungeeworgorai Creek, ten miles above the main Western Road; and a specimen labelled *Sphenopteris*, from the Bulloo River, in the south-western corner of the Colony, is included in the collections of the Queensland Museum, Brisbane.

In addition to the localities already enumerated, coal has been found in the Rolling Downs Formation at Malta, east of Tambo (three seams in thirty-six feet, one seam three and a-half feet thick); at the head of Bungeeworgorai Creek, north-east of Mitchell (a thick seam); and at Dulbydilla, on the Western Railway.

\* And those from the Lake Eyre Basin in South Australia. See "Age of the Mesozoic Rocks of the Lake Eyre Basin." By Prof. R. Tate, *Proc. Austr. Assoc. Adv. Sci.* (1888), i., p. 228.

† Transcontinental Railway Report, by R.L.J. Brisbane: by Authority: 1885.

‡ Report on the Search for Coal between Dalby and Roma. Brisbane: by Authority: 1879.

Although, as has already been said, the fauna of the Rolling Downs must be treated as a whole, as must also its flora should determinable specimens be obtained, in the following list the various fossiliferous localities hitherto exploited are kept apart, as the distinction may be found to have some possible utility in the future. The list is intended by us to correct and supersede all previously published lists. A considerable number of fossils are now recorded for the first time, my Colleague having carefully worked over an immense mass of material, which I was able to place in his hands, in addition to collections made by Mr. G. Sweet, and Mr. C. W. De Vis from Queensland, other fossils from the north-west corner of New South Wales in the Mining and Geological Museum, Sydney, and a collection obligingly forwarded on loan by Professor R. Tate, from the Lake Eyre Basin, South Australia. The Geological Survey Collection includes valuable donations of Rolling Downs fossils by the following gentlemen:—The Hon. A. C. Gregory, Brisbane; Messrs. J. B. Henderson, M.I.C.E., Hydraulic Engineer, Brisbane; R. Sexton, C.E., Brisbane; J. Falconer, Brisbane; the late James Smith, Rockhampton; E. K. Ogg, Rockhampton; — Goffage, Tambo; Rowland Morrisby, Blackall; S. Sharwood, Aramac; E. R. Edkins, Mount Cornish; Julius von Berger, Winton; G. Cramieri, Winton; P. F. Sellheim, Gympie; R. Sefton, Townsville; W. Landers, Townsville; A. Brand, Townsville; A. C. Macmillan, C.E., Ayr; R. Gray, Hughenden; J. Burkitt, Maxwellton, near Hughenden; J. Hugh Moor, Manfred Downs, near Cloncurry; P. W. Pears, Normanton; the Rev. T. W. Ramm, late of Hughenden; W. L. Mackinnon, A.M.I.C.E., Irrigation Engineer, Brisbane; and D. P. Ryan, Hughenden.

Among the most interesting of these donations are portions of skeletons of *Ichthyosaurus* and *Plesiosaurus* (?), to which my Colleague refers in his Notes. The former is from the bed of the Flinders, thirty-five miles below Richmond Downs (Mr. J. Burkitt); Flinders River, at Manfred Downs (Mr. J. Hugh Moor); and Flinders River, near Glendower (Mr. W. L. Mackinnon). The latter is from Manfred Downs (Mr. J. Hugh Moor).

We are indebted to Mr. C. W. De Vis for an opportunity of examining a portion of an *Ichthyosaurus* from Marathon Station, on the Flinders, and vertebrae of *Plesiosaurus* from the Walsh River. The specimens are in the Queensland Museum.\* These fossils confirm the previous determination of such genera made by Prof. McCoy, and, from their strong Cretaceous *facies*, assist in approximately fixing the age of the deposits in which they occur.

Another very remarkable fossil is a fragment of a Ganoid fish, measuring about ten inches square, from Hughenden, presented by Mr. D. P. Ryan. This fish is specifically identical with that first discovered by Mr. George Sweet, of Brunswick, Melbourne, in the Rolling Downs, near Hughenden, and named *Belonostomus Sweeti*. It is described by my Colleague and Mr. A. Smith Woodward as "the largest species of the Mesozoic Ganoid *Belonostomus* which has yet been found. The fish lived in the same geological period, in Western Europe, India, and Brazil, and the present discovery is thus of great interest, as extending still further the ascertained geographical range of this genus during Mesozoic times."

In the southern portion of the area watered by the Warrego, Paroo, and Cooper's Creek, there is a great thickness of the "Rolling Downs" strata, but it is probable that the uppermost beds are frequently *débris* of the Desert Sandstone accumulated on a continental land surface during Tertiary times. In this region the thick brushwood of mulga and gidyah forms a strong contrast to the open downs. This subject will be further referred to in treating of the Moondilla gold discoveries, in Chapter XXXV.

\* See R. Etheridge, Junr., Proc. Linn. Soc. N.S.W., 1889, Vol. iii., Pt. 2, pp. 405 and 410.

An admirable description is given of the Rolling Downs Beds, as they are developed in South Australia, in a Paper on "The Mesozoic Plains of South Australia," by Mr. H. Y. Lyell Brown, Government Geologist of that Colony, read before the Australasian Association for the Advancement of Science,\* from which a few extracts may with advantage be made in this place.

"The area over which the Mesozoic beds form the surface rock, or are only thinly covered by those of Tertiary formation, extends east from the boundaries of New South Wales and Queensland, westward to the boundary of Western Australia; northward it is bounded by the Musgrave Ranges and Lat. 26°, and southward by an irregular line extending from the northern edge of the Nullarbor Plains in Western Australia, round by the Warburton Range and the northern extremity of the main range to the vicinity of Lake Frome, near which it passes into New South Wales. Here and there along the telegraph line from Hergott Springs to the Peak and Charlotte Waters, the Dennison, Margaret, and other ranges, composed of Primary rocks, protrude through it in the form of islands, rising above the general surface in places to a height of 1,000 feet or more." . . . "The general level of this vast territory varies from some two hundred feet above sea-level to twenty five or thirty feet below it, in the case of Lake Eyre."

After describing the "Table-land and Table-hill country" and the "Stony Downs," which he refers to as "either of Upper Cretaceous or Lower Tertiary age," Mr. Brown continues as follows:—

"Below and surrounding the table-hills and stony downs, are the soft silt plains, which, together with the former, cover the gypseous clays, marls, calcareous shales, limestones, sand, and gravel drifts of Cretaceous age. The greatest thickness of these beds, which has been proved by boring at Tarkininna, is about 1,200 feet." . . . "Bores have been sunk by the Government in this formation at Tarkininna, where artesian water was tapped at 1,200 feet, and at Hergott, Coward Springs, Strangway Springs, &c., where a large supply of water was attained at an average depth of some three hundred feet. The supply from some of these bores is over a million gallons per day." . . . "The fossils which occur in this formation are found in masses and nodules of limestones, and in the calcareous shales, but generally they are most plentiful in the former, which are often entirely composed of them."

It is very satisfactory to have our long-entertained view of the age of the Rolling Downs Formation of Queensland confirmed, as regards the extension of the same formation into South Australia, by such a competent authority as Prof. Ralph Tate, of Adelaide, who, in a Paper "On the Age of the Mesozoic Rocks of the Lake Eyre Basin,"† makes the following remarks:—

"The occurrence of *Crioceras* and a Ceratite-like Ammonite among the common fossils of the Lake Eyre Basin demands their relegation, as also those of Wollumbilla, to the Cretaceous System;" and again:—"The European identities alleged to occur in the Wollumbilla beds, are *Lingula ovalis*, *Avicula braamburiensis*, *Belemnites paxillosus*, *Serpula intestinalis*, and *Rhynchonella variabilis*. Relying on Mr. Moore's determinations, I have persistently advocated the Jurassic age of the Lake Eyre fossils; but, forced to abandon that position by the more decided Cretaceous *facies* of recently acquired species, it becomes necessary to reinvestigate the claims of the fore-mentioned species to bear the names attached to them."

\* Proc. Austr. Assoc. Adv. Sci., 1888, i., p. 241.

† *Ibid.*, p. 228.

Professor Tate then gives the following list of Cretaceous fossils from the Lake Eyre Basin:—

Species.	Other Occurrences.
<i>Crioceras australe</i> , Moore ... ..	Upper Maranoa.
<i>Belemnites australis</i> , Phillips ... ..	Grey Range; Wollumbilla.
<i>Canhami</i> , Tate ... ..	
<i>Sellheimi</i> , Ten. Woods ... ..	Palmer River.
<i>eremos</i> , Tate ... ..	Wollumbilla.
<i>Cinulia Hochstetteri</i> , Moore ... ..	Wollumbilla.
<i>Natica variabilis</i> , Moore ... ..	Wollumbilla; Maryborough.*
( <i>Natica lineata</i> , Eth.) ... ..	
<i>Dentalium arcotinum</i> , Forbes ( <i>Dentalium lineatum</i> , Moore) ... ..	Wollumbilla; India.
<i>Avicula Barklyi</i> , Moore ( <i>Avicula reflecta</i> , Moore; <i>Avicula orbicularis</i> , Hudleston) ... ..	Grey Range; Wollumbilla.
<i>Avicula umbonalis</i> , Moore ... ..	Wollumbilla.
<i>corbiensis</i> , Moore ... ..	Wollumbilla.
<i>Aucella hughendenensis</i> , Eth. ( <i>Aucella Liversidgei</i> , Eth. junr.) ... ..	Grey Range; Hughenden; Marathon.
<i>Cytherea Clarkei</i> , Moore ( <i>Cyprina expansa</i> , Eth.) ... ..	Grey Range; Wollumbilla; Maryborough.*
<i>Cytherea Woodwardiana</i> , Hudleston ... ..	
<i>Gervilleia angusta</i> , Hudleston ... ..	
<i>Mytilus inflatus</i> , Moore ( <i>Mytilus linguloides</i> , Hudleston) ... ..	Wollumbilla; Palmer River.
<i>rugocostatus</i> , Moore ( <i>Mytilus Scouleri</i> , Tate) ... ..	Wollumbilla.
<i>Myacites McCoyii</i> , Moore ... ..	Wollumbilla.
<i>rugosa</i> , Moore ( <i>Myacites australis</i> , Hudleston) ... ..	Wollumbilla.
<i>Nucula quadrata</i> , Eth. ... ..	Maryborough.*
<i>truncata</i> , Moore ... ..	Wollumbilla.
<i>Pecten psila</i> , T. Woods (? <i>Pecten socialis</i> , Moore) ... ..	Grey Range; Wollumbilla.
<i>Trigonia nasuta</i> , Eth. ... ..	Maryborough.*
<i>lineata</i> , Moore ... ..	Wollumbilla.
<i>Lingula subovalis</i> , Davidson ... ..	Wollumbilla; England.

"In addition to the above, are species of:—*Ammonites* (with the sutures of *Ceratites*), *Alaria*, two sp., *Modiola*, *Natica*, *Leda*, *Pecten*, *Gervilleia*, *Pinna*, *Arcomya*, *Pleuromya*, *Rhynchonella*, and of several uncertain genera of bivalves."

#### LIST OF FOSSILS FROM THE ROLLING DOWNS FORMATION IN QUEENSLAND.

##### WOLLUMBILLA.

###### FORAMINIFERA.

- Cristellaria acutauricularis*, Ficht. and Moll.  
*Cristellaria acutauricularis*, var. *longicostata*, Moore.  
*Cristellaria cultrata*, Montfort, var. *radiata*, Moore.  
*Dentalina communis*, D'Orb.  
*Vaginulina striata*, D'Orb.  
*Polymorphina gibba*, D'Orb.  
*Polymorphina lactea*, Walker and Jacob.  
*Planorbulina lobatula*, D'Orb.  
*Planorbulina Ungeriana*, D'Orb.

###### SILICISPONGIA.

- Purispionia Clarkei*, Bowerbank.

###### NEOCRINOIDEA.

- Pentacrinus australis*, Moore.

###### TUBICOLA.

- Serpula intestinalis*, Phillips.

##### CIRRIPEDIA.

- Traces (?) adhering to *Panopaea*.

##### POLYZOA (Gymnolemata).

- Lepralia* ? *oolitica*, Moore.

##### BRACHIOPODA.

- Terebratella Davidsoni*, Moore.  
*Argiope* ? *wollumbillensis*, Moore.  
*Argiope* ? *punctata*, Moore.  
*Rhynchonella rustica*, Moore.  
*Rhynchonella solitaria*, Moore.  
*Discina apicalis*, Moore.  
*Lingula ovalis*, J. Sowerby.

##### PELECYPODA.

- Pecten Moorei*, Eth. fil.  
*Pecten æquilineatus*, Moore.  
*Pecten socialis*, Moore.  
*Lima Gordoni*, Moore.  
*Lima* ? *multistriata*, Moore.  
*Lima* ? *braamburiensis* (Sby.), Phillips.?

\* Desert Sandstone. (R.L.J.)

# LIST OF FOSSILS FROM THE ROLLING DOWNS FORMATION IN QUEENSLAND—continued.

## WOLLUMBILLA—continued.

### PELECYPODA—continued.

*Oxytoma ? simplex*, Moore.  
*Pseudavicula anomala*, Moore.  
*Pseudavicula australis*, Moore.  
*Maccoyella Barklyi*, Moore.  
*Maccoyella reflecta*, Moore.  
*Maccoyella ? umbonalis*, Moore.  
*Maccoyella ? corbiensis*, Moore.  
*Maccoyella ? substriata*, Moore.  
*Perna gigantea*, Moore.  
*Mytilus Tenison-Woodsi*, Eth. fil.  
*Mytilus rugocostatus*, Moore.  
*Mytilus inflatus*, Moore.  
*Modiola unica*, Moore.  
*Arca praelonga*, Moore.  
*Nucula Cooperi*, Moore.  
*Nucula truncata*, Moore.  
*Nucula australis*, Moore.  
*Trigonia lineata*, Moore.  
*Astarte wollumbillensis*, Moore.  
*Cyprina Clarkei*, Moore.  
*Macrocallista ? plana*, Moore.  
*Glycimeris rugosa*, Moore.  
*Goniomya depressa*, Moore.

### GASTEROPODA.

*Dentalium wollumbillensis*, Eth. fil.  
*Cinulia Hochstetteri*, Moore.  
*Actæon depressus*, Moore.  
*Delphinula ? reflecta*, Moore.  
*Natica variabilis*, Moore.  
*Natica ornatissima*, Moore.

### CERPHALOPODA.

*Teuthis*.  
*Belemnites australis*, Phillips.  
*Belemnites eremos*, Tate.  
*Belemnites Sellheimi*, Ten. Woods.  
*Crioceras australe*, Moore.

## BUNGFEEWORGORAI CREEK.

(Twenty miles south east of Mount Abundance.)

### PELECYPODA.

*Maccoyella Barklyi*, Moore.  
*Maccoyella reflecta*, Moore.  
*Maccoyella umbonalis*, Moore.  
*Maccoyella ? corbiensis*, Moore.  
*Maccoyella ? substriata*, Moore.  
*Mytilus rugocostatus*, Moore.  
*Glycimeris rugosa*, Moore.  
*Corimya Wilsoni*, Moore.

## AMBY RIVER.

### NEOCERINOIDEA.

*Pentacrinus australis*, Moore.

## AMBY RIVER.—continued.

### PELECYPODA.

*Glycimeris ? Maccoyi*, Moore (between "Amby and Maranoa Rivers").  
*Corimya Wilsoni*, Moore.

### BLYTHESDALE.

(Fifteen miles from Wollumbilla.)

### PELECYPODA.

*Maccoyella Barklyi*, Moore.  
*Maccoyella corbiensis*, Moore.  
*Tancredia ? plana*, Moore.

### GASTEROPODA.

*Natica variabilis*, Moore.

## MOUNT CORBY.

### PELECYPODA.

*Maccoyella corbiensis*, Moore.

## MITCHELL RAILWAY STATION BORE.

### PELECYPODA.

*Pecten ?* (Pl. 21, Fig. 5.)

## MARANOA RIVER.

(Half a mile above Mitchell Railway Station.)

### PELECYPODA.

*Maccoyella Barklyi*, Moore.  
*Pseudavicula anomala*, Moore.  
*Corbicella ? maranoama*, Eth. fil.  
*Glycimeris Tatei*, Eth. fil.  
*Glycimeris rugosa*, Moore.  
*Gastrochaena australis*, Eth. fil.

### GASTEROPODA.

*Natica variabilis*, Moore.

## GORDON DOWNS.

(Near Roma.)

### PELECYPODA.

*Tancredia ? sp. ind.*, Eth.  
*Homomya, sp. ind.*, Eth.

### GASTEROPODA.

*Pleurotomaria ? Cliftoni*, Eth.

## MINMI.

(Near Roma.)

### PELECYPODA.

*Oxytoma ? simplex*, Moore.  
*Cyprina Clarkei*, Moore.  
*Corimya Wilsoni*, Moore.

## MARANOA RIVER.

### PELECYPODA.

*Pseudavicula anomala*, Moore.  
*Pseudavicula australis*, Moore.  
*Cyprina Clarkei*, Moore.  
*Glycimeris rugosa*, Moore.

LIST OF FOSSILS FROM THE ROLLING DOWNS FORMATION IN  
QUEENSLAND—continued.

MARANOA RIVER—continued.

CEPHALOPODA.

*Belemnites australis*, Phillips ("Upper Maranoa River").

*Crioceras australe*, Moore ("Upper Maranoa District").

WARREGO RIVER.

CEPHALOPODA.

*Hamites ? laqueus*, Eth. fil.

GREY RANGES.

(Mount Stewart Run, N.S.W. Boundary of South Australia and Queensland).

PELECYPODA.

*Pecten psila*, Ten. Woods.

*Trigonia mesembria*, Ten. Woods.

CEPHALOPODA.

*Belemnites oxyis*, Ten. Woods.

NIVE DOWNS.

PELECYPODA.

*Mactra trigonalis*, Moore.

GLANMIRE BLOCK.

(North-east end. Seventeen miles south-west of Tambo.)

PELECYPODA.

*Cucullæa Hendersoni*, Eth. fil.

*Cytherea ? Hudlestoni*, Eth. fil.

GASTEROPODA.

*Dentalium wollumbillensis*, Eth. fil.

*Actæon depressus*, Moore.

CEPHALOPODA.

*Ammonites inflatus*, J. Sowerby, var. (Pl. 34, ff. 1-4.)

BARCOO RIVER.

(Six miles above Northampton Downs Station.)

PELECYPODA.

*Aucella hughendenensis*, Eth.

BARCOO DISTRICT.

PELECYPODA.

*Mytilus ingens*, Ten. Woods.

TAMBO AND BLACKALL ROAD.

(Nine miles from Tambo.)

PELECYPODA.

*Trigonia*, sp. ind. (b), (Pl. 21, f. 21).

CEPHALOPODA.

*Belemnites*, sp. (Pl. 35, ff. 15 and 16).

EVORA STATION.

(Twenty-five miles north-east of Blackall.)

PELECYPODA.

*Cytherea (Cyprina ?) Moorei*, Eth. fil.

EVORA STATION—continued.

GASTEROPODA.

*Anchura ? Wilkinsoni*, Eth. fil.

BARCOLDINE.

CEPHALOPODA.

*Belemnites Canhami*, Tate.

*Ammonites Flindersi*, McCoy (at Railway Station).

*Hamites ? laqueus*, Eth. fil. (on Wellshot Run).

*Nautilus Hendersoni*, Eth. fil. (from Barcaldine, and also from Ilfracombe).

COREENA WOOLSHED.

PELECYPODA.

*Aucella hughendenensis*, Eth.

PITCHERY CREEK.

(Barrington's Station, Central Queensland.)

REPTILIA.

*Plesiosaurus Sutherlandi*, McCoy.

MOUNT CORNISH.

(Well seven miles east of Station.)

PELECYPODA.

*Inoceramus pernoides*, Eth. (at 200 feet).

CEPHALOPODA.

*Crioceras Edkinsi*, Eth. fil. (at 230 feet).

ARAMAC.

PELECYPODA.

*Pecten*, sp. ind. (Pl. 21, ff. 7 and 9).

*Oxytoma rockwoodensis*, Eth. fil.

*Aucella hughendenensis*, Eth. (in well at 244 feet).

*Inoceramus Crispiei*, Mantell ? (in well at 238 and 244 feet).

*Nucula quadrata*, Eth. (in well at 244 feet).

*Nucula*, sp. ind. (in well at 244 feet).

*Glycimeris aramacensis*, Eth. fil.

CEPHALOPODA.

*Belemnites Canhami*, Tate (in well at 238 feet).

*Belemnites ? Liversidgei*, Eth. fil.

*Ammonites inflatus*, J. Sowerby, var. (Pl. 34, ff. 1-4).

*Ammonites Flindersi*, McCoy (in well at 290 feet).

*Ancylloceras Flindersi*, McCoy (in well at 224 and 238 feet).

*Crioceras*, sp. ind. (Pl. 33, ff. 4-6—in well at 284 feet).

MUTTABURRA BORE.

PELECYPODA.

*Inoceramus Crispiei*, Mantell ?

*Palæomæra ? sp. ind.* (Pl. 26, f. 16).

LIST OF FOSSILS FROM THE ROLLING DOWNS FORMATION IN  
QUEENSLAND—continued.

TOWER HILL.  
(Landsborough River.)

CEPHALOPODA.

*Hamites ? laqueus*, Eth. fil.

ROCKWOOD STATION.  
(Landsborough River.)

PELECYPODA.

*Pecten*, sp. ind. (Pl. 21, f. 7 and 9).

*Amusium*, sp. ind. (Pl. 21, f. 4 and 4a).

*Oxytoma rockwoodensis*, Eth. fil.

*Aucella hughendenensis*, Eth.

LANDSBOROUGH RIVER.  
(Five and a half miles north-north-west of  
Rockwood Station.)

PELECYPODA.

*Aucella hughendenensis*, Eth.

JIRKING CREEK.  
(Near Rockwood.)

PELECYPODA.

*Aucella hughendenensis*, Eth.

STONE HUT, ROCKWOOD CREEK.

PELECYPODA.

*Aucella hughendenensis*, Eth.

LANDSBOROUGH RIVER.

PELECYPODA.

*Inoceramus Carsoni*, McCoy.

*Inoceramus marathonensis*, Eth.

CEPHALOPODA.

*Belemnites Canhami*, Tate.

*Ancyloceras Flindersi*, McCoy.

*Crioceras australe*, Moore.

*Crioceras*, sp. ind. (Pl. 33, f. 4, 5, and 6).

REPTILIA.

*Notochelone costata*, Owen.

HEAD OF THOMPSON RIVER, BOWEN  
DOWNS.

PELECYPODA.

*Inoceramus*.

WINTON.

PELECYPODA.

*Unio* (from Government well).

GYPSUM MINE, CHOLLARTON.

PELECYPODA.

*Ostrea vesiculosa*, J. Sowerby.

WARRIANA BORE.

(Twenty-five miles from Hughenden, on the  
Winton Road.)

PELECYPODA.

*Aucella hughendenensis*, Eth. (at 351 feet).

CEPHALOPODA.

*Ammonites inflatus*, J. Sowerby (at 375 feet).

UPPER FLINDERS RIVER.

PELECYPODA.

*Cyprina Clarkei*, Moore.

CEPHALOPODA.

*Belemnites Sellheimi*, Ten. Woods.

*Belemnites Canhami*, Tate (near Hughenden).

REPTILIA.

*Ichthyosaurus australis*, McCoy (Glendower  
Station).

HUGHENDEN STATION.

PELECYPODA.

*Aucella hughendenensis*, Eth.

CEPHALOPODA.

*Ammonites Flindersi*, McCoy.

*Ammonites Sutherlandi*, Eth.

*Ammonites Daintreei*, Eth.

PISCES.

*Aspidorhynchus*.

*Belonostomus Sweeti*, Eth. fil. and Smith  
Woodward.

FLINDERS RIVER.

(Seven miles above Marathon Station.)

INSECTA (NEUROPTERA).

*Aeschna flindersensis*, H. Woodward.

PELECYPODA.

*Aucella hughendenensis*, Eth.

*Inoceramus pernoides*, Eth.

MARATHON STATION.

(Flinders River.)

PELECYPODA.

*Aucella hughendenensis*, Eth.

*Inoceramus Carsoni*, McCoy.

*Inoceramus pernoides*, Eth.

*Inoceramus marathonensis*, Eth.

*Inoceramus elongatus*, Eth.

CEPHALOPODA.

*Ammonites Sutherlandi*, Eth.

REPTILIA.

*Ichthyosaurus marathonensis*, Eth. fil.

*Plesiosaurus Sutherlandi*, McCoy.

MAXWELTON.

(Flinders River.)

CEPHALOPODA.

*Nautilus Hendersoni*, Eth. fil.

BASE OF WALKER'S TABLE MOUNTAIN.

(Flinders River.)

PELECYPODA.

*Inoceramus Carsoni*, McCoy.

*Inoceramus Sutherlandi*, McCoy.



LIST OF FOSSILS FROM THE ROLLING DOWNS FORMATION IN  
QUEENSLAND—continued.

BASE OF WALKER'S TABLE MOUNTAIN

—continued.

CEPHALOPODA.

- Belemnites Canhami*, Tate.  
*Ammonites Flindersi*, McCoy.  
*Ammonites Sutherlandi*, McCoy.  
*Ancylloceras Flindersi*, McCoy.

REPTILIA.

- Ichthyosaurus australis*, McCoy.  
*Plesiosaurus macrospondylus*, McCoy.  
*Plesiosaurus Sutherlandi*, McCoy.

FLINDERS RIVER, ON CAMBRIDGE  
DOWNS RUN.

(Six miles from Richmond Downs Station.)

CEPHALOPODA.

- Belemnites Canhami*, Tate.

RICHMOND DOWNS.

(Flinders River.)

PISCES.

- Lamna Daviesii*, Eth. fil.

FLINDERS RIVER.

(Three miles above Richmond Downs Station.)

PELECYPODA.

- Inoceramus Carsoni*, McCoy.  
*Inoceramus Sutherlandi*, McCoy.

FLINDERS RIVER.

(Thirteen and a half miles below Richmond  
Station.)

PELECYPODA.

- Inoceramus Carsoni*, McCoy.

FLINDERS RIVER.

(Twenty-one miles below Richmond Downs  
Station.)

PELECYPODA.

- Inoceramus Sutherlandi*, McCoy.

FLINDERS RIVER.

(Thirty-five miles below Richmond Downs.)

REPTILIA.

- Ichthyosaurus australis*, McCoy.

NEAR MANFRED DOWNS.

(Flinders River.)

(Lat. 20° 5' S., Long. 141° 43' E.)

REPTILIA.

- Ichthyosaurus australis*, McCoy.

NEELIA CREEK.

(Near Cloncurry.)

PELECYPODA.

- Aucella hughendenensis*, Eth.

JULIA CREEK.

(Hughenden and Cloncurry Road.)

GASTEROPODA.

- Natica Jackii*, Eth. fil.

TATE RIVER.

CEPHALOPODA.

- Crioceras australe*, Moore.

WALSH RIVER.

PELECYPODA.

- Pecten socialis*, Moore.  
*Maccoyella Barklyi*, Moore.  
*Pinna*, sp. ind. (Pl. 20, ff. 16 and 17).  
*Cyprina Clarkei*, Moore.  
*Macrocallista ? plana*, Moore.  
*Unicardium Meekii*, Eth. fil.

CEPHALOPODA.

- Belemnites Sellheimi*, Ten. Woods.  
*Ammonites* (Pl. 42, ff. 10 and 11).  
*Ancylloceras Taylora*, Eth. fil. (head of River).  
*Crioceras australe*, Moore.  
*Crioceras irregulare*, Ten. Woods (head of  
River).

REPTILIA.

- Plesiosaurus*.

PALMER RIVER.

PELECYPODA.

- Mytilus inflatus*, Moore.

CEPHALOPODA.

- Belemnites Sellheimi*, Ten. Woods.  
*Ammonites olene*, Ten. Woods.  
*Crioceras australe*, Moore.  
*Crioceras irregulare*, Ten. Woods.

KAMILAROI.

(Leichhardt River.)

PISCES.

- Otodus appendiculatus*, Agassiz.

LEICHHARDT RIVER.

(Seven miles from mouth of Gunpowder Creek.)

PELECYPODA.

- Aucella hughendenensis*, Eth.

INDEFINITE LOCALITIES IN THE  
ROLLING DOWNS.

PELECYPODA.

- Lævicardium Brazieri*, Eth. fil.

The above List of Fossils has enabled my Colleague to refer the Rolling Downs Formation to the Cretaceous; although he admits that the formation contains "an admixture of Oolitic as well as Cretaceous life." As the succeeding formation (the Desert Sandstone) is, although it rests unconformably on the Rolling Downs, also recognised as Cretaceous, we class the Rolling Downs and Desert Sandstone respectively as Lower and Upper Divisions of that Period.

The break between the Rolling Downs and the underlying Ipswich Formation is complete so far as regards its life-history. The only fossils they have in common are two species of *Unio* in each, but they are not the same species, and, even if they were, the presence of such a widely distributed form would have little significance.

With the succeeding formation, the Desert Sandstone, although separated from it by a violent unconformability, the Rolling Downs appears to have more in common, unless, indeed, the early collectors, who did not suspect that there was any distinction, mixed up fossils from the two formations as developed in the neighbourhood of Wollumbilla and Mount Abundance. With this reservation, we recognise as common to the two formations the genera *Rhynchonella*, *Ostrea*, *Lima*, *Pseudavicula*, *Maccoyella*, *Cucullæa*, *Nucula*, *Trigonia*, *Cyprina*, *Palæomæra*, *Glycimeris*, *Pecten*, *Natica*, and *Belemnites*; and the species *Maccoyella Barklyi*, *M. reflecta*, *M. ? umbonalis*, *M. ? corbiensis*, *M. ? substriata*, *Cyprina Clarkei*, *Glycimeris rugosa*, *Nucula quadrata*, and *Natica variabilis*.

#### ARTESIAN WELLS.

The Western Interior of the Colony, especially that part which is covered by the Rolling Downs Formation, is covered with rich grasses, but in dry seasons the greater portion of the grass ceases to be available for stock, owing to the distance from water. For many years the Government and the pastoral lessees of the Crown laboured to counteract this disadvantage by excavating tanks and throwing dams across water-courses for the conservation of water. The enormous expense of these undertakings, however, prevented the general adoption of this method of meeting the difficulty. In many cases, besides, the soil proved unsuitable for the retention of water; and in some instances I believe that the rainfall is so slight that, if the whole of it could have been conserved in the districts where it fell, it would not have sufficed to render the herbage available.

The great drought which prevailed in the year 1885 brought about a feeling akin to desperation, and I was sent along with Mr. J. B. Henderson, Hydraulic Engineer, with instructions to study the structure of the Western Country, and report whether there was a chance of success in boring for artesian water, and if so, to determine the site of the first experiment. I came to the conclusion that the conditions were similar all over the Western Downs; that the strata of the "Rolling Downs Formation" cropped out on the flanks of the eastern ranges, and dipped westward under the plains, with undulations regarding which we had, and could have, no data, so that it was impossible to predict at what depth water might be struck in any individual case. In these circumstances we recommended that the first bore should be made at Blackall, which appeared at the time to be in the sorest need.

The bore at Blackall proved successful, although, owing to an accident, it was not the first to strike artesian water, the Barcaldine Bore having carried off that honour. Since then boring for artesian water has been carried on vigorously all over the Western Interior, and a week seldom passes without information reaching me of the success of some fresh bore.

Operations were carried on at first with the Pennsylvania Beam-Borer, and latterly with the Canadian Pole-Borer. These instruments carry on the work rapidly, and at a

comparatively small expense. But in one important particular they fall short of the requirements of a perfect boring tool. It is impossible to obtain a record of the strata cut through. Had such a record been obtained, and systematically preserved, there must have been by this time an accumulation of data invaluable for the purpose of directing and economising future operations. Owing to the manner in which the material is pounded up, the strata of one bore can never be "read" with those of another. All that it is open to us to record is the depth at which artesian water has been met with in various localities, and with this, for the present, we must rest content. I append to this Chapter, for reference, such records as have reached me on the subject.

From this record it will be observed that in some cases artesian water has been met with at comparatively shallow depths in the vicinity of springs, and for the most part in the vicinity of thermal springs. The subjects of artesian water and thermal springs have evidently an intimate connection.

To begin with thermal springs, the first thing we discover is how extremely vague and unsatisfactory are the explanations offered by the best authorities. The whole of the light hitherto thrown on the subject may be summed up in the following quotation from Dr. A. C. Peale's Report on the Thermal Springs of the Yellowstone National Park\* :— "Everywhere that observations have been made, there appears to be an increase (of temperature) as we descend towards the centre of the earth. In this increase of heat, of course, we have sufficient reason for the heat of springs coming from a great depth. In many thermal springs, however, as in our Yellowstone Region, this regular increase in temperature is not sufficient to account for the high temperature, and we must look for the cause in plications and faults or in the volcanic rocks in which the springs are located."

Rocks of igneous origin (*e.g.*, basalts) may, and in some cases must, still retain at comparatively shallow depths enough of their original heat to raise the temperature of any water with which they may come in contact to what is usually understood by the boiling-point—*i.e.*, the boiling-point under the pressure of one atmosphere. But the contact must take place at depths so shallow that the pressure of suprajacent water or rock shall not raise the boiling-point of water above the temperature of the rock. Every lava-flow which appears at the surface must be connected with underground ramifications, consisting essentially of a "reservoir" and a channel. The material in both reservoir and channel must, at least in the case of all but very recent eruptions, be consolidated; but rocks of the lava class are very bad conductors of heat, or, in other words, part with their original heat very slowly. The connection of hot springs in all parts of the world with recent or, geologically speaking, not very ancient volcanic rocks, is now well known.

Careful observations have shown that, so far as the investigations could be carried, the internal heat of the Earth increases about 1° Fahrenheit for every fifty or sixty feet of depth, and it might be thought that, from this cause alone, wherever water could penetrate to sufficient depth it would be boiling, but this can easily be shown to be an error. Assuming an increase of one degree in fifty feet, and the surface temperature to be seventy degrees, a depth of at least seven thousand one hundred feet would have to be attained before the rock forming that portion of the earth's crust, or water in contact with it, would have a temperature of 212°. Nevertheless, a column of water reaching from the surface to a depth of seven thousand one hundred feet would not by any means have its base at the boiling-point, because the boiling-point of water is raised enormously by pressure. From observations made at the Great Iceland

\* Twelfth Ann. Report U. S. Geol. Geogr. Survey of the Territories for 1878, Pt. 2, Washington, 1883.

Geyser it was found that the boiling-point rose from  $210^{\circ}$  at the surface, to  $278^{\circ}$  at the depth of seventy-seven feet. This ratio, giving a rise of the boiling-point of  $68^{\circ}$  in seventy-seven feet, would make the boiling-point of water at seven thousand one hundred feet not  $212^{\circ}$ , but  $6,366^{\circ}$  (and that merely under the pressure of a column of water, while the pressure of a column of rock would be about two and a-half times as much). These astonishing figures prove that *the ratio of the rise in the boiling-point being higher than the ratio of the increase of the earth's temperature with depth, water would never be raised to boiling-point by the internal heat of the earth alone.*

At the same time, though water would not *boil* from the internal heat of the earth, yet where it exists beneath seven thousand one hundred feet it must always have a temperature above  $212^{\circ}$ . Immediately upon the production of an outlet, whether by natural means, such as a fault or earthquake fissure, or by artificial means, such as a bore, the relief of pressure would bring about a rise of the water in the fault, fissure, or borehole analogous to that of the rise of the mercury in the tube of a thermometer.

In the case of a thermal spring it is not necessary that the fissure should be open down to a depth of seven thousand one hundred feet, as the requisite high temperature may be found when the water is in contact with subterranean igneous rocks still retaining much of their original heat.

In the artesian wells of our Western Interior, the water issues at temperatures which are high, although still far below boiling-point—*e.g.*, Back Creek  $70^{\circ}$ , Aramac Private Bore No. 1,  $81^{\circ}$ , Muckadilla  $124^{\circ}$ , Barcaldine  $102^{\circ}$ , Saltern Creek Government Bore  $115^{\circ}$ , Saltern Creek Private Bore No. 3,  $128^{\circ}$ , Blackall  $119^{\circ}$ , Tambo  $98^{\circ}$ , Cunnamulla  $106^{\circ}$ , Charleville  $106^{\circ}$ , Manfred Downs No. 2,  $110^{\circ}$ , No. 10,  $118^{\circ}$ .

There are, as already mentioned, few records of the strata passed through, but at all events there is nothing to show that any igneous rocks whatever have been met with in the bores. The high temperature of the water may be taken to be the result solely of the internal heat of the earth. It will, however, be observed that the temperature of the water does not bear a constant relation to the depth. The internal heat must, therefore, have affected the temperature of the water elsewhere than in the places where the water has been tapped.

Now, although the temperature of the water of the artesian wells is somewhat high, *the depth at which it has been struck is in no case great enough to account for it.* For example, the temperature of  $119^{\circ}$  attained at 1,663 feet in the Blackall Bore would not be reached by the rock before the bore had been carried to the depth of 2,450 feet, assuming that the constant surface temperature is  $70^{\circ}$ , and the increase with depth one degree in fifty feet. The water, I take it, must have reached, with the undulations of the permeable strata containing it, lower depths than those at which it has been tapped by the bores. This is to my mind a confirmation of the view I have always held, that the Rolling Downs strata undulate considerably.

The commonly accepted theory of artesian wells is that a permeable stratum, with impermeable strata both above and below, carries water from its outcrop down to whatever depth it may be buried beneath accumulations of later date, and that on tapping the water-charged stratum the water will rise to, or near, the level of the outcrop of the stratum. Till lately I have rigorously adhered to this theory, which perfectly accounts for many of the best-known artesian wells of Europe and America, but in the case of the Queensland wells it is doubtful if the strata in which the water has been tapped crop out at elevations sufficient to give the pressure required to raise the water to the surface.

It is indeed difficult to identify the outcrops of the strata in which the water has been tapped, but at all events they cannot be at higher levels than the line where the edge of the Rolling Downs Formation meets the Palæozoic rocks on which the formation rests. The difficulty of the case is increased by the fact that the Rolling Downs Formation is generally overlapped by the Desert Sandstone Formation, so as to obscure its junction with the Palæozoic rocks. It is probable that the outcrops of the permeable strata are seldom more than five hundred feet above the level of the surface of the ground in the places where the permeable strata have been tapped, with the result of finding overflowing artesian water.

Mr. J. Hugh Moor, Manager of Manfred Downs Station, on the Flinders, has courteously forwarded to me samples of the rock in which the water from his "No. 2 Well" was struck. A more favourable medium for the conveyance of water could scarcely be imagined. It is a sandstone so open that water can be sucked through it as easily as through a piece of spongy iron. But even if, instead of a stone filter (however open), the water had to pass through an iron pipe, there would still be such a loss by friction in two or three hundred miles, that it could not rise quite to the level of its source.

My belief is that the water flowing from an elevated source down the plane of a permeable stratum intercalated between two impermeable strata must rise, in a bore tapping the permeable stratum, to near the level of its source, and be aided in its rise by expansion due to heat acquired in its passage over a portion of the stratum now lying at a lower level than that at which it was tapped by the bore.

The Desert Sandstone, which, where not denuded, always rests on the Rolling Downs Formation at high levels, and unconformably, is itself a great reservoir of water, which issues in springs from the cliffs at the edges of the table-lands which are its characteristic feature. Some of the water with which the Desert Sandstone is charged must find its way into any permeable beds in the Rolling Downs Formation whose outcrop may happen to be covered by the Desert Sandstone.

The expansion of the water itself would probably be greatly assisted by the elasticity of imprisoned gases increasing in volume in proportion as they are relieved of pressure.

It has been suggested that the pressure of water implied by Australian artesian wells may be derived from strata in the mountains of New Guinea, or even of the Himalayas. It must be recollected, however, that only open and porous strata can possibly act as conduits for water, and that strata of this character (gravels, conglomerates, grits, and sandstones) are necessarily local in their distribution, as they could not possibly be deposited in a deep sea far from the land. It is within the bounds of possibility, seeing how little we know of New Guinea, that the Rolling Downs Formation may extend across the strait separating Queensland and New Guinea, and that the "head of water" may be derived from the latter island, as we know at least that Cretaceous rocks occur in New Guinea.\* From what has already been said as to the non-continuity of open and permeable strata across oceanic depths, it is, however, to say the least, highly improbable. As regards the continuity of Cretaceous rocks of the Rolling Downs age from Queensland to India, the idea is too extravagant to be entertained for a moment by any Geologist.

Considering the paramount importance of the question of artesian water in the West, I have thought it well to record briefly in the following pages such particulars as I have been able to ascertain regarding the wells already sunk. For a great deal of this information I am indebted to Mr. J. B. Henderson, M.I.C.E., Government Hydraulic Engineer.

\* From the recent information collected by Mr. A. Gibb Maitland (see Chapter on British New Guinea), it must be admitted that this is hardly possible.

It is a well-known fact that in California, the London Basin, and many other localities where artesian wells are numerous, the overflow has diminished, and in some cases altogether stopped. For the sake of argument I have summed up the amount which would overflow from *all* the Queensland bores mentioned in the following pages if they were allowed to run without check. The total amounts to 58,177,760 gallons per day, or 21,234,882,400 gallons per annum, which is equal to the total annual rainfall over nearly seventy-two square miles, taking it at an average of 20.45 inches.\* Granting that the rainfall is greater in the coastal regions where the water-bearing strata may be supposed to crop out, what may be called the expenditure still bears an alarmingly large proportion to what may be called the income, for it must not be forgotten that the length of the outer boundary line of the Lower Cretaceous Formation is the *maximum* possible length of the outcrop of any water-bearing or other stratum in it. Even a thick water-bearing stratum would only occupy with its outcrop a breadth of a few chains at most; so that it would take many miles *in length* of the outcrop of such a stratum to receive that portion of the rainfall of a square mile which is not carried off by streams or evaporated. It may, therefore, be safely predicted that if artesian wells become much more numerous, and if all be allowed to overflow, a diminution of the supply may shortly be looked for. It is gratifying that the Government is taking steps to prevent the waste of artesian water. It seems to me that the use of the water should be restricted to stock-watering and town supply. Even irrigation I should regard as wilful waste, unless indeed, after the lapse of years, there should be found to be no diminution in the supply.

#### PARTICULARS OF BORES IN THE ROLLING DOWNS.

##### ROCKLANDS.

A bore at Rocklands Station, on Pring Creek, a tributary of the Georgina River, in the Barkly Table-land, still, I believe, incomplete, shows several alternations of strata, including, as I read it, not only Lower Cretaceous strata, but also the Desert Sandstone, some Tertiary rocks, and overlying basalts.

The site of the bore is about six hundred feet above sea-level, and about Lat. 19° 40', and Long. 138° 15'. The section has been kindly handed to me by Mr. A. Rourke:—

									Feet.
Surface	{	Hardened clay and boulders	...	...	...	...	...	...	33
		Red clay	...	...	...	...	...	...	3
Basalt	{	Rotten limestone	...	...	...	...	...	...	8
		Rotten limestone with basalt seams	...	...	...	...	...	...	12
		Basalt and lime rock	...	...	...	...	...	...	16
		Lime rock	...	...	...	...	...	...	5
		Basalt	...	...	...	...	...	...	4
		Lime rock	...	...	...	...	...	...	14
Tertiary P	{	Red sand	...	...	...	...	...	...	3
		Lime, iron, and sandstone	...	...	...	...	...	...	17
		Rotten limestone and red clay	...	...	...	...	...	...	21
		Rotten rock and boulders	...	...	...	...	...	...	16
		Porous lime rock with flinty seams	...	...	...	...	...	...	8
		Hard lime rock	...	...	...	...	...	...	11
		Rotten porous limestone	...	...	...	...	...	...	30
		Hard lime rock	...	...	...	...	...	...	1
		Rotten rock	...	...	...	...	...	...	8
		Lime rock	...	...	...	...	...	...	12

\* This is the average rainfall at Charleville for the eleven years ending with 1890.

								Feet.
	Rotten rock	...	...	...	...	...	...	4
	Hard flinty rock	...	...	...	...	...	...	13
	White sand	...	...	...	...	...	...	3
	White sand rock	...	...	...	...	...	...	2
	Flinty lime	...	...	...	...	...	...	5
	Flinty lime, shattered, with crevices	...	...	...	...	...	...	23
	Flinty lime rock	...	...	...	...	...	...	7
	White sand— <i>Water</i>	...	...	...	...	...	...	4
Desert Sand-	Shattered white sand rock	...	...	...	...	...	...	5
stone ?	Flinty, hard sand rock	} <i>Water</i>	...	...	...	...	...	5
	White sand rock		...	...	...	...	...	8
	Hard compact sand rock	...	...	...	...	...	...	10
	White sand rock— <i>Water</i> *	...	...	...	...	...	...	10
	Flint	...	...	...	...	...	...	3
	Sand rock	...	...	...	...	...	...	8
	Flint	...	...	...	...	...	...	4
	Brown sand (August 1, 1890)	...	...	...	...	...	...	9
	Sand rock with seams of limestone...	...	...	...	...	...	...	19
Cretaceous ?	Pure limestone	...	...	...	...	...	...	37
	Cavern	...	...	...	...	...	...	6
	Yellow ochre and black sand with stones	...	...	...	...	...	...	6
								412

WARREND A.—Lat. 22° 45', Long. 140° 55'.†

Several private artesian wells have been sunk on this Run, yielding large supplies of water from shallow depths. The deepest (No. 5) is seven hundred and fifteen feet, and supplies 750,000 gallons per day. It is stated that several mud springs break out in this neighbourhood between the different channels of the Hamilton River. It may be noted that Warrenda New Station is not in the position shown on the map (which is the site of the Old Station), but about sixty miles higher up the river. The deep bore above referred to is on Polygammon Creek. No. 4 Bore is five hundred and eleven feet deep, and supplies 150,000 gallons per day. No. 2 Bore is one hundred and eighty-four feet deep, and supplies 70,000 gallons per day.‡

No. 6 Bore. Supply, 1,000,000 gallons per day. Depth, seven hundred feet.§ Water struck at five hundred and fifty feet.||

No. 7 Bore. Depth, seven hundred and seventy-three feet. Water overflowing at the rate of 400,000 gallons per day.¶

MAXWELLTON, No. 1 BORE.

Water overflowing at the rate of 300,000 gallons per day. Depth not stated.\*\*

AVON DOWNS.—Lat. 20°, Long. 137° 30'.

A bore has been sunk on this Station, which is situated on Rankin's Creek, Georgina River (on the South Australian side of the border), at a height of about five hundred and fifty-four feet above sea-level. Water was struck at two hundred feet but did not flow over the surface.

\* Rose to 275-feet level. No mud, though there was a current.

† Approximate latitudes and longitudes are given throughout for the purpose of enabling the reader to locate the bores on the map.

‡ Hydraulic Engineer's Report on Water Supply for Year ending 30th June, 1891. Brisbane: by Authority: 1891. And information furnished by Mr. G. Neville Griffiths.

§ *Brisbane Courier*, 4th September, 1891.

|| *Ibid.*, 25th January, 1892.

¶ *Ibid.*, 26th March, 1892.

\*\* *Ibid.*, 10th February, 1892.

MANFRED DOWNS (Private).—Lat. 20° 8', Long. 141° 40'.

*No. 1 Bore.*

Clay	...	...	...	...	...	...	...	...	60 feet
Blue shale	...	...	...	...	...	...	...	...	570 "
Water-bearing sandstone	...	...	...	...	...	...	...	...	48 "

The water rises six feet above the surface in a one-inch pipe at the rate of 50,000 gallons per day.\*

*No. 2 Bore.*

Blue shale to	...	...	...	...	...	...	...	665 feet
Shale and sandstone to	...	...	...	...	...	...	...	720 "
Hard fine-grained porous sandstone with water at	...	...	...	...	...	...	...	720 "
Softer and coarser sandstone with water at	...	...	...	...	...	...	...	760 "

The water flows over the surface at the rate of 526,000 gallons per day, with a temperature of 110° F.†

In a table attached to the Hydraulic Engineer's Annual Report, 30th June, 1891, the following additional information is given regarding bores at Manfred Downs :—

No.	Depth in Feet.	Supply per diem.	—	Temperature.
		Gallons.		
1	177	22,000	Overflowing.	
2	128	12,000	"	
3	86	14,000	"	
4	210	10,000	"	
5	200	20,000	Not overflowing; supply pumped.	
6	98	16,000	Overflowing.	
17	678	50,000	"	106°
18	760	525,000	"	110°
9	707	200,000	"	102°
10	733	250,000	"	118°

RICHMOND DOWNS, Flinders River (Private).—Lat. 20° 45', Long. 143° 10'.

There are five bores on this Station. No. 1 Bore is six hundred and ninety-eight feet deep. Water flows over the surface at the rate of 1,600,000 gallons per day.‡ Temp., 96°.|| No. 2 Bore is situated on Alexandra Creek, on the north side of the Flinders. At four hundred feet a supply, estimated at 1,000,000 gallons per day, was struck. The Newspaper Correspondent, in announcing the discovery, mentions that the bore was put down in eight days, and adds that "the water is splendid, and equal to if not better than that in the last bore."¶ Total depth, four hundred and eighty feet; yield, 1,200,000 gallons per day; temperature, 92°.||

No. 4 Bore tapped a supply of water at a depth of six hundred feet, yielding 2,000,000 gallons per day.\*\*

No. 5 (?) Bore. Depth six hundred feet; water overflowing at the rate of 2,000,000 gallons per day. "The result of the present bore brings the total supply for the five bores at less than 1,000 feet each, to 8,000,000 gallons per day."††

\* Letter from Mr. J. Hugh Moor, 1st January, 1889.

† *Ibid.*, 12th December, 1889.

‡ Nos. 7 and 8 are evidently the bores named Nos. 1 and 2 respectively in Mr. Moor's letters.

§ *Townsville Bulletin*, 26th June, 1891.

|| Hydraulic Engineer's Report, 30th June, 1891.

¶ *Townsville Bulletin*, 23rd July, 1891.

\*\* *Brisbane Courier*, 11th November, 1891.

†† *Brisbane Telegraph*, 9th November, 1891.



## MARATHON, No. 1 BORE.

Water overflowing at the rate of 2,300,000 gallons per day; depth not stated.\*

MACKINLAY BORE, on the Mackinlay River (Government).—Lat.  $21^{\circ} 25'$ , Long.  $141^{\circ} 26'$ .

When at the depth of eight hundred and thirty-seven feet, water rose over the surface at the rate of 160,000 gallons per day. Total depth, 1,002 feet; overflow, 350,000 gallons per day. The bore pierced the following strata:—"Alluvial layer; yellow clays; blue and grey shales, irregularly interstratified with thin beds of grey and brown sandstone, now and then of a slightly greenish tint; and calcareous seams. Occasionally mundic was brought up in the sand pump. The water was tapped in coarse open sandstone."†

TOORAK, No. 2 BORE, Mackinlay River (Private).

Depth, 1,550 feet; water overflowing at the rate of about 1,000,000 gallons per day.‡

STRATHFIELD STATION, Mackinlay River, Burke District (Private).

Depth, eight hundred and thirty feet; water flowing at the rate of 500,000 gallons per day.§

WERNA.—Lat.  $21^{\circ} 50'$ , Long.  $143^{\circ}$ .

Water was struck in a well on the boundary of Werna and Ayrshire Downs Runs at one hundred and forty feet, and again at one hundred and eighty feet. The water rose seventy feet in the well; at least it stood at one hundred and thirty-four feet from the surface in December, 1881, when I visited the place after a protracted drought. The section met with in this well has already been described (p. 402).

SHEPPARD'S WELL, Winton.—Lat.  $22^{\circ} 22'$ , Long.  $143^{\circ} 3'$ .

No water was met with in this well, which was sunk to the depth of one hundred and thirty-five and a-half feet. The strata met with have already been described (p. 402).

GOVERNMENT WELL, Winton (behind Court House).

No water at one hundred and fifty feet. The strata have already been described (p. 403).

WINTON BORE (Government).

Depth, at 30th June, 1891, 1,800 feet.

Strata:—"An alluvial layer; sandy shale, soft and indurated fine-grained grey shales, occasionally of a slightly greenish tint, and bluish-coloured sandstones, irregularly interstratified. One or two thin beds of what appeared to be carbonaceous shales, and some dark material, evidently coal, were passed through. Several small samples of gypsum were brought up by the sand pump." At 1,260 feet, a small stream of water was struck, which rose to within about fifty feet from the surface.†

VINDEX, near Winton.—Lat.  $22^{\circ} 28'$ , Long.  $143^{\circ} 19'$ .

In a well at the Station, water was struck, about 1880, at one hundred and ten feet, and rose twenty-five feet. The strata have already been described (p. 403).

\* Rockhampton *Bulletin*, December, 1891.

† Hydraulic Engineer's Report, 30th June, 1891.

‡ *Brisbane Courier*, 16th March, 1892.

§ *Ibid.*, 27th October, 1891.

A second well was sunk at Crawford's Creek, nine miles east of Vindex, and water was obtained at one hundred and fifty feet. The strata have already been described (p. 403).

A bore was sunk on Vindex Run, about seven miles N. 15° E. of the Station, but at the depth of one hundred and eighty-seven feet had not struck water. The strata have already been described (p. 403).

MANUKA.—Lat. 21° 45', Long. 143° 25'.

On Manuka Station two wells were sunk prior to 1881. The first, close to the Station, struck water at eighty feet. More came in at one hundred and two feet. At one hundred and forty feet a large supply came in, making about thirty-six feet of water in twenty-four hours, and a few days later seventy feet of water stood in the shaft. The water was rather brackish, but cattle drank it readily. In the second well a little water came in at one hundred feet. More was found at one hundred and thirty feet, and the quantity increased till at one hundred and eighty feet a large supply was struck. The water stood seventy-seven feet deep, and was less brackish than that of the first well. The strata passed through in both wells were grey flags or shales, with bands of bluish sandstone, containing indistinct plant-remains and a few shells. The specimens of the latter, preserved by Mr. Anderson, of Manuka, had fallen to pieces on exposure to the air, and nothing remained of them but fragments.

BOWEN DOWNS BORES (Private).—Lat. 22° 30', Long. 145°.

No. 1. Depth, nine hundred and seventy feet; overflow, 493,600 gallons per day; temperature, 90°; pressure per square inch, 70 lb.

No. 2.\* Depth, 1,874 feet; overflow, 1,500,000 gallons per day; temperature, 108°.

No. 3. Depth, 1,112 feet; overflow, 864,000 gallons per day.†

COREENA BORES, near Aramac (Private).—Lat. 23° 25', Long. 145° 25'.

On this Run there are three bores, A, B, and C, which have tapped an overflowing supply, and four (D, E, F, and G) which have struck water which rises but does not overflow.

Bore A is nine hundred and four feet deep; overflow, 1,500,000 gallons per day.

Bore B is 1,350 feet deep; overflow, 350,000 gallons per day.

Bore C ‡ is 1,100 feet deep; overflow, 150,000 gallons per day.

Bore D, at two hundred and eighty-five feet, and Bore E, at four hundred and fifty feet, tapped small supplies of water which did not overflow.

Bore F, at seven hundred and fifty feet, struck a supply which rose at first to forty feet, and afterwards to twelve feet from the surface, and from which 40,000 gallons per day can be pumped.

Bore G. Depth, three hundred feet; water rises to within four feet of the surface; 25,000 gallons per day can be pumped.†

CORINDA BORE, near Aramac (Private).—Lat. 22° 40', Long. 145° 40'.

Depth, five hundred feet. Water flowing over surface at the rate of 150,000 gallons per day.§

\* In middle of "Herbert" Block.

† Hydraulic Engineer's Report, 30th June, 1891.

‡ Known as Dalzell's Bore, Newark Block, Coreena.

§ *Townsville Bulletin*, 7th June, 1890.

**SALTERN CREEK BORES (Private).—Lat. 23° 30', Long. 144° 50'.**

Bore No. 1. Depth, 1,130 feet; water overflows at the rate of 175,000 gallons per day; temperature, 108°.\*

No. 2. Depth, 1,605 feet; water overflows at the rate of 220,000 gallons per day; temperature, 113°; pressure, 31 lb. per square inch.\*

No. 3. Depth, 1,970 feet; water overflows at the rate of 690,000 gallons per day; temperature, 128°; pressure, 49 lb. to the square inch.\*

No. 4. Depth, 1,560 feet; water overflows at the rate of 1,000,000 gallons per day.†

**SALTERN CREEK BORE (Government).**

Depth, nine hundred and seventy-eight feet; water overflows at the rate of 17,200 gallons per day; temperature, 115°; pressure, 38 lb. to the square inch.\*

**ANALYSIS OF THE WATER BY R. MAR, GOVERNMENT ANALYST.**

Total fixed salts	...	...	...	...	...	...	...	83.50
Carbonate of calcium	...	...	...	...	...	...	...	1.04
" " magnesium	...	...	...	...	...	...	...	trace
Chlorides and carbonates of sodium and potassium	...	...	...	...	...	...	...	81.42
Oxide of iron	...	...	...	...	...	...	...	1.04

Unfit for irrigation. May be used for other purposes.

**BARCADDINE BORE (Government).—Lat. 23° 30', Long. 145° 10'.**

Site nine hundred and fifty-three feet above sea-level; depth of bore, six hundred and ninety-one feet nine inches; water rises twelve feet four inches above surface in a ten-inch pipe at the rate of 175,000 gallons per day; temperature, 102°; pressure, 17 lb. to the square inch; cost of bore, £775.‡

In his next Annual Report, Mr. Henderson notes: "This bore has maintained its reputation for yielding a large supply of excellent fresh water. Nothing has been done since the date of my last report to enable the Department to shut off with safety the flow of the water, by means of the screw-plug and valve with which the casing is furnished." Thrown open for bathing purposes with beneficial effects.\*

**ANALYSES OF WATER BY R. MAR, GOVERNMENT ANALYST.**

	First.	Second.
Total fixed salts	66.50	63.70
Organic matter	trace	trace.
Chlorine	small quantity	small quantity.
Sulphuric acid	trace	trace.
Ammonia	trace	trace.
Albuminoid ammonia	slight trace	slight trace.

Hardness, 2° 8'. The salts in solution are chiefly bicarbonates of sodium and potassium. Therefore, while the water may be used for domestic purposes, they are unfit for use in irrigation.

**BACK CREEK BORE, east of Barcaldine.—Lat. 23° 35', Long. 145° 45'.**

This bore, sunk for the Railway Department, struck, at the depth of one hundred and eighty feet, water which overflows at the rate of 72,000 gallons per day, with a temperature of 70° and a pressure of 5 lb. to the square inch.

\* Hydraulic Engineer's Report, 30th June, 1891.

† *Brisbane Courier*, 18th March, 1892.

‡ Hydraulic Engineer's Report, 30th June, 1889.

**FRASER'S SELECTION BORE**, seven miles North of Barcaldine (Private).—Lat. 23° 23', Long. 145° 10'.  
Depth, 1,175 feet; overflow, 600,000 gallons per day.

**FRASER AND McLACHLAN'S BORE**, near last (Private).  
Depth, seven hundred feet; overflow, 200,000 gallons per day.

**TARA BORE**, twenty miles West of Barcaldine (Private).—Lat. 23° 30', Long. 144° 35'.  
Depth, 2,003 feet; overflow, 250,000 gallons per day.

**BARCALDINE WELL** (Private).

I have been informed by Mr. J. V. S. Desgrand that a well at Barcaldine Station, one hundred feet deep, struck salt water; as did also a well on the Barcaldine Run, on the eastern side of the Alice.

**DARR RIVER DOWNS BORES** (Private).—Lat. 23°, Long. 144°.

Bore No. 1. Depth, 2,007 feet; brackish water rose to seventy feet from surface; temperature, 107°; 20,000 gallons per day can be pumped.

Bore No. 2. Depth, 1,007 feet; 40,000 gallons per day can be pumped.

Bore No. 3. Depth, 2,700 feet; overflow, 50,000 gallons per day.

Bore No. 4. Depth, 800 feet; 4,800 gallons per day can be pumped.\*

**ALICE DOWNS BORE** (Private).—Lat. 24° 10', Long. 145° 30'.  
Depth, 2,145 feet; overflow, 100,000 gallons per day.\*

**EVORA BORE** (Private).—Lat. 24° 15', Long. 145° 30'.  
Depth, 2,036 feet; overflow, 43,000 gallons per day; temperature, 116°.

**HOME CREEK BORE** (Private).—Lat. 23° 55', Long. 145° 20'.  
From a bore, 1,760 feet deep, water overflows at the rate of 100,000 gallons daily.\*

**BLACKALL BORE** (Government).—Lat. 24° 25', Long. 145° 30'.  
Depth, 1,668 feet; water overflows at the rate of 300,000 gallons per day; temperature, 119°; pressure, 65 lb. to the square inch.\* In his "Annual Report," 30th June, 1890, Mr. Henderson has the following note:—"This work is in good order, and, so far as I am aware, the discharge and pressure of the water have not diminished. The flow of water from this bore, like that from all the others, save Barcaldine, can be completely shut off and otherwise controlled at pleasure."

**ANALYSIS OF WATER BY R. MAR, GOVERNMENT ANALYST.**

Total fixed salts	...	...	...	...	...	...	71.40
Organic matter	...	...	...	...	...	...	Trace.
Chlorine	...	...	...	...	...	...	Small quantity.
Sulphuric acid	...	...	...	...	...	...	Trace.
Ammonia	...	...	...	...	...	...	Trace.
Albuminoid ammonia	...	...	...	...	...	...	Slight trace.

Hardness, 3°. The salts in solution are chiefly bicarbonates of sodium and potassium. Therefore, while the waters may be used for domestic purposes, they are unfit for use in irrigation.\*

The unsuccessful "Town Well" at Blackall, two hundred and fifty feet deep, gave a section of a portion of the strata probably similar to those met with in the bore (see page 405).

**WESTLANDS BORE** (Private).—Lat. 23° 55', Long. 143° 48'.  
Depth, 2,036 feet; no overflowing water.

\* Hydraulic Engineer's Report, 30th June, 1891.

TAMBO BORE (Government).—Lat. 24° 50', Long. 146° 15'.

Depth, 1,002 feet; water overflows at the rate of 200,000 gallons per day; temperature, 98°; pressure, 12 lb. to the square inch.\* In his report Mr. Henderson states: "On 10th September [1888] good water was tapped in sandstone, and a larger supply of excellent fresh water was struck at nine hundred and ten feet; at 1,002 feet drilling was stopped. An improved screw-plug and stop-valve have been fitted to the inner string of casing, by which means the flow of water is stopped or otherwise controlled at pleasure. Generally stated, the bore was sunk in sandstone and blue clay shales of the Cretaceous Formation. Up to the 30th June [1889] the expenditure on this bore was £1,514 11s. 2d., including £330 12s. 11d. for transport of boring plant and casing, and £176 18s. for casing."

ANALYSIS OF WATER BY R. MAE, GOVERNMENT ANALYST.

Total fixed salts	...	...	...	...	...	...	...	40.60
Organic matter	...	...	...	...	...	...	...	0.70
Chlorine	...	...	...	...	...	...	...	8.55
Sulphuric acid	...	...	...	...	...	...	...	trace.
Ammonia	...	...	...	...	...	...	...	trace.
Albuminoid ammonia	...	...	...	...	...	...	...	trace.

Hardness, 2° 25'. The water is fit for domestic and other uses.†

TAMBO STATION, No. 2 BORE (Private).

Water flowing at the rate of 15,000 gallons per day; depth not stated; boring continued.‡

LANSDOWNE BORE (Private).—Lat 25° 8', Long. 146° 13'.

Depth, 2,485 feet; water rises to within seventeen feet of surface.†

GRIFFITH'S BORE, ten miles east of Muttaborra.—Lat 22° 37', Long. 144° 32'.

Depth, two hundred and ninety-three feet. The prevailing strata were fine-grained grey sandstones, with some grey shales similar to those in the Aramac Well. Specimens of *Inoceramus*, &c., were obtained at two hundred and seventy-four feet.§

ARAMAC.—Lat. 23°, Long. 145° 15'.

The "Town Well," Aramac, was sunk to the depth of three hundred feet, in or before 1885. A section of the strata met with has already been given (p. 405). The shaft was five feet by three feet. Salt water was struck at forty-seven feet, and made five feet in twenty-four hours for some time, but in October, 1885, had diminished to three feet. A trifling amount of fresh water was met with at ninety-eight feet.

Artesian water has been met with on Aramac Run in two private bores. No. 1, six hundred and fifty feet deep, yields 2,000,000, and No. 2, 1,011 feet deep, yields 1,750,000 gallons of overflowing water daily. The temperature of the water is 81° in the case of No. 1 Bore, and 99° in the case of No. 2. The pressure per square inch is—No. 1, 25 lb.; No. 2, 39 lb.†

The following items of information regarding wells in the Aramac District were supplied to me in October, 1885, by Mr. William Forsyth:—

(1.) *Aramac Run, eight miles above Aramac*.—Bore, one hundred feet deep; no water; strata as in Aramac Well.

\* Hydraulic Engineer's Report, 30th June, 1889.

† *Ibid.*, 30th June, 1891.

‡ *Brisbane Courier*, 27th October, 1892.

§ Information supplied by Mr. William Forsyth, manager of Aramac Station.

(2.) *Ten miles up creek from Aramac.*—Bore, one hundred and eighty-seven feet; no water; strata as in Aramac Well.

(3.) *On right bank of Aramac Creek, ten miles above Aramac.*—Bore, two hundred and twenty-seven feet; no water; strata as in Aramac Well. The bore is near some springs which are said to break out only in dry seasons.

#### LEICHHARDT DOWNS, near Aramac.

"A second supply of artesian water has been struck on that Selection, the yield being 280,000 gallons per day. The depth of the bore is 2,488 feet. This is the second bore on Leichhardt Downs, the No. 1 having tapped water which flows at the rate of 1,000,000 gallons per day."\*

#### CALEDONIA STATION, Aramac.

Depth, five hundred and seventy-seven feet; water overflowing at the rate of 100,000 gallons per day.†

#### NORTHAMPTON DOWNS.—Lat. 24° 32', Long. 145° 50'.

The following information regarding wells on Northampton Downs was supplied in 1885, by the late Mr. F. R. Murphy, M.L.A., the Proprietor of the Run :—

(1.) *Coomdarmah Block*, south bank of Barcoo, three miles back from river. Depth, one hundred and twenty-five feet. Small supply of fresh water.

(2.) *Glenusk Block*, north bank of Barcoo, four miles from river. Depth, one hundred and fifty feet. Small supply of fresh water.

(3.) *Northampton Block*, north side of Barcoo, ten miles from river. Depth, two hundred feet. Small supply of water, as salt as brine.

(4.) *Same Block*, north side of Barcoo, five miles back from river. Depth, one hundred and eighty feet. Fair supply of water, but brackish and unfit for stock.

*Northampton Downs Private Bore.* Depth, 1,334 feet; overflow, 25,000 gallons per day.‡

#### DARBY POINT BORE (Government).—Lat. 25° 30', Long. 146° 30'.

This bore is situated about midway between Augathella and Tambo. It was abandoned after "it had reached a depth of six hundred and sixty-two feet in sandstone and shales of the Cretaceous Formation."§

#### STEWART'S BORE (Government).—Lat. 24° 20', Long. 146° 20'.

This bore is in the Desert Sandstone Formation, under which heading see Remarks (Chapter xxxiii.)

#### WELLSHOT BORE (Government).—Lat. 23° 33', Long. 144° 55'.

"This bore is situated about six and a-half chains southerly from the 370 miles 33 chains peg from Rockhampton, on the proposed extension of the Central Railway from Barcaldine to Longreach, and its altitude is about eight hundred and fifty-seven feet above sea-level." The bore was abandoned at 1,160 feet, owing to the loss of tools. "The strata bored were clay, shales, and sandstones of the Cretaceous Formation."§

\* *Brisbane Courier*, 12th December, 1891.

† *Brisbane Observer*, 9th November, 1891.

‡ Hydraulic Engineer's Report, 30th June, 1891.

§ *Ibid.*, 30th June, 1889.

TARA. No. 3 BORE, Wellshot Run, near Barcaldine (Private).

Water struck at 1,930 feet; supply, 20,000 gallons per day. At 2,033 feet the volume had increased to 75,000 gallons, and at 2,050 feet to about 150,000 gallons. At 2,100 feet the supply was between 150,000 and 200,000 gallons. Still sinking. The temperature at 1,930 feet was 110°, and it gradually increased to 135° at 2,100 feet.\*

ADAVALE.—Lat. 25° 55', Long. 144° 36'.

In 1885 I visited a well at Adavale, which had been sunk to a depth of one hundred feet through white shales. Very salt water was standing fifty feet deep. The site of the well is about 1,000 feet above sea-level.

GUMBARDO SAWMILL WELL, near Adavale.—Lat. 26° 10', Long. 144° 45'.

In passing this well, in 1891, I was informed by Mr. F. Learmouth, Manager of the Station, that the total depth was seventy-five feet. The spill-bank showed that fine hard shales were occasionally parted by beds of fine-grained ferruginous sandstone, and that there is a very coarse siliceous grit near the bottom. A well at the Station shows similar material. After my visit to the Moondilla Gold Field (*see* Chapter xxxv.), I am inclined to suspect that the strata cut in this and the preceding bore may prove to be Tertiary, and not Cretaceous.

CHARLEVILLE BORE (Government).—Lat. 26° 26', Long. 146° 15'.

"This bore is situated within a few yards of the Railway Terminus, and its altitude is nine hundred and seventy-five feet above sea-level." "The strata pierced may be briefly stated as follows, viz.:—Sand, clays, and gravels of the Upper Cretaceous [Desert Sandstone?] Formation to two hundred and seventy feet; thence clays, sandstones, and light-coloured shales of the Lower Cretaceous Formation, interstratified with thin beds of gravel to eight hundred and seventy-five feet; thence well-defined blue shales of the latter formation to the bottom in sandstone, where the large supply of water was found. From one hundred and seventy-five to one hundred and ninety-five feet from the surface excellent fresh water was struck in gravel, but it did not flow. At three hundred and ten feet a further supply was tapped, and the bore was finished at 1,370 feet 10 inches. It is lined with two strings of A. and J. Stewart's swollen-jointed wrought-iron casing. The outer string consists of two hundred and fifty-eight feet of ten-inch tubes,  $\frac{1}{8}$  inches thick; the inner of 1,219 $\frac{1}{2}$  feet, eight inches in diameter,  $\frac{9}{32}$  inches thick. Before inserting and fixing the plug and valve for controlling the flow, the water was spouting with a velocity of fully eleven feet per second, and to a height of about three feet above the top of the eight-inch casing. On closing the valve the pressure was found to be 95 lb. per square inch, which has since increased to 100 lb. The volume is now fully 3,000,000 gallons per twenty-four hours. The water is clear, colourless, soft, and potable. Its temperature is about 106° Fahr., and when cool it is, as far as I can judge, wholesome and palatable. For a little time after the plug was inserted the valve was occasionally choked by large pieces of shale, which the water brought from the bottom, and the valve had to be frequently taken off to clear it. This inconvenience was remedied as follows:—One hundred and ninety-three feet of six-inch casing were screwed together, the lower sixty-three feet of which were well perforated and then allowed to drop to the bottom, the top of the six-inch casing overlapping the eight-inch by forty-two and a-half feet. This mode of dealing with the difficulty had the desired effect; no trouble has accrued since. By this means the flow and pressure have been maintained intact, and, so far as I

\* Rookhampton Bulletin, December, 1891.

am aware, this well may be pronounced the best in Australia, as far as regards volume\* although the pressure is not so great as at Cunnamulla, where it is fully 185 lb. per square inch.† When the valve is fully opened, and a 'director' with an orifice of one and a-half inches is fitted thereon, the water shoots to a height over one hundred feet from the surface. The cost was £2,388 14s. 5d., including supervision of the work, and £86 8s. 5d. for caretaking to 30th June last" [1889].‡

In the 1890 Report, Mr. Henderson gives the following analysis of the water by Mr. R. Mar:—"Total fixed salts 70·70, chlorine 12·95, hardness 3°; and a note is appended that the water is "unfit for irrigation—may be used for other purposes."

In an article by Mr. Ludwig Bruck on "The Mineral Springs of Australia"§ is the following note on an analysis (furnished by the Department of Mines) of water from "Charleville district," which I presume to refer to the Charleville Artesian Well:—

"This water is of a strong saline character, and contains 604·78 grains of mineral matters per gallon, viz.:—Chloride of sodium, 347·42 gr.; chloride of lime, 100·59 gr.; chloride of magnesium, 63·89 gr.; sulphate of soda, 79·27 gr.; and 13·61 gr. carbonate of lime. This spring contains so much chloride of lime as to make it unfit for drinking purposes; however, used as baths it would no doubt be found useful in scrofula, enlargement of the liver, and derangement of the spleen; at a tepid temperature (say from 85° to 94° F.) it should be useful in cutaneous diseases, and taken as hot baths (from 98° to 112° F.) in rheumatic and similar affections. I cannot say whether this water is identical with the water struck at the same place in a bore 1,350 feet deep, the temperature of which is over 112° F."

MURWEH BORE (Private).—Lat. 26° 58', Long. 146° 20'.

Depth, 1,230 feet; overflow, 140,000 gallons per day; temperature, 98°.

MUCKADILLA BORE (Government).—Lat. 26° 40', Long. 148° 20'.

This bore is near Muckadilla Station, on the Western Railway, six miles east of Dalby. It is 3,262 feet deep, being the deepest in the Colony, or indeed in the Australian Colonies. The following section has been supplied to me by Mr. Henderson:—

	Feet.	Depth.
Yellow clay ... ..	50	...
Black shale ... ..	370	...
Sandstone ... ..	24	...
Black shale ... ..	234	678
Grey pipeclay ... ..	116	794
Grey sandstone ... ..	195	989
Sand drift, white and lignite; tapped water	21	1,010
Shale, brown and grey ... ..	61	1,071
Sandstone conglomerate, grey ... ..	26	1,097
Shale, brown and grey ... ..	54	1,151
Sand drift, white and brown; water increased	127	1,278
Shale, brown ... ..	15	1,293
Sand drift, grey ... ..	32	1,325
Shale, grey, siliceous... ..	123	1,448
Sandstone, brownish grey ... ..	85	1,533
Sand drift, white and grey ... ..	148	1,681
Shale, blackish ... ..	150	1,831

\* See Noorama and Burranbilla Bores.

† An Artesian Well in Dakota has a reported pressure of 200 lb. per square inch—the greatest I have any knowledge of.

‡ Annual Reports of the Hydraulic Engineer, 30th June, 1889 and 1890.

§ *Australasian Medical Gazette* for January, 1891.



	Feet.	Depth.
Sandstone, grey ... ..	29	1,860
Shale, slate-coloured to brownish-grey ... ..	98	1,958
Shale, black, with streaks of coal ... ..	277	2,235
Sandstone and shale, soft ... ..	265	2,500
Sandstone, white; water flowing 10,000 gallons per day ... ..	618	3,118
Sandstone, micaceous; overflow of water, 12,960 gallons per day at 3,170 feet ... ..	52	3,170
Sandstone, white and soft; water overflowing at rate of 23,000 gallons per day; temperature, 124° F. ... ..	92	3,262

## ANALYSIS OF THE WATER BY R. MAR, GOVERNMENT ANALYST.

Total fixed salts ... ..	34.30
Carbonate of calcium ... ..	1.01
Carbonate of magnesium ... ..	trace.
Chlorides and carbonates of sodium and potassium ... ..	31.77
Oxide of iron ... ..	1.52

The water is fit for domestic and other purposes.

## MITCHELL BORE (Government).—Lat. 26° 35', Long. 147° 50'.

A bore was sunk here for the Railway Department in 1885, two hundred yards west of the station. I was informed by Mr. John Falconer, who was in charge of the bore, that the section showed one hundred and eighty-eight feet of blue shales beneath twenty feet of drift. Water was met with at two hundred and eight feet in a "sandy drift" beneath the shales, and rose to nine feet from the surface. On the 3rd October, 1885, I saw it standing twenty-eight feet from the surface. The water would supply, by pumping, eight hundred to 1,000 gallons per day. The site of the bore is 1,104 feet above sea-level.

## BURENDA BORE (Private).—Lat. 25° 57', Long. 146° 50'.

Depth, 1,900 feet; water rises to within thirty feet of surface.

## BOLLON OR SIXTY-FIVE MILE BORE (Government).—Lat. 28° 3', Long. 147° 55'.

This bore is situated about sixty-five miles from St. George, on the road to Cunnamulla. In July, 1891, the depth of 1,840 feet had been attained, and water was overflowing at the rate of 30,000 gallons per day. Strata:—Alluvium, clay, sand, pipeclay, limestone, dark and grey-coloured clay, shales, and sandstones of various texture, interstratified in irregular order, the last stratum being coarse grey sandstone.\*

I am informed (21st September, 1891) that the bore has been stopped at 2,362 feet, the overflow being about 180,000 gallons per day, at a temperature of 125°.

## CUNNAMULLA BORE (Government).—Lat. 28° 5', Long. 145° 40'.

"In February [1889] a supply of artesian water was struck at nine hundred and seventy-five feet, but boring operations were continued in the hope of striking a larger supply. As boring was continued the flow increased, until, on the 21st of February, a supply of 22,500 gallons per hour [equal to 540,000 gallons per day] of excellent fresh water was tapped at a depth of 1,402 feet. Its temperature is 106° F., and its pressure is fully 185 lb. per square inch at the surface. On completion of boring operations the six-inch casing was fitted with a recessed screw-plug and stop-valve, by means of which the flow of water is controlled, and at pleasure supplied to consumers. The cost of this bore,

\* Hydraulic Engineer's Report, 30th June, 1891.

including a sum of £488 19s. 2d. for the carriage of the plant and casing from Charleville, and £403 for casing, was £1,927 17s. 5d. Generally stated, the strata pierced were clays, shales, and light sandstones of the Cretaceous formation.”\*

In his next Annual Report Mr. Henderson observed that “This work is in excellent order, but the high pressure of the water, which I believe has increased from 185 to 190 lb. per square inch, is very trying on the valve. A new one of superior design and stronger make will shortly be sent out to replace the old one, which has partly given way.

ANALYSES BY R. MAB, GOVERNMENT ANALYST.

					First.		Second.
Total fixed salts	...	...	...	...	22.10	...	25.75
Organic matter	...	...	...	...	trace	...	trace
Chlorine	...	...	...	...	trace	...	0.70
Ammonia	...	...	...	...	.0015	...	.0016
Albuminoid ammonia	...	...	...	...	.0011	...	.0012

Hardness, 3°. The water is suitable for general domestic use.†

CAWARRA, No. 1 BORE, twenty-five miles east of Hungerford.—Lat. 29°, Long. 144° 50'.

In this bore, at the depth of 1,810 feet, a supply of water was met with which overflows at the rate of 10,080 gallons per day. I have been shown a specimen of *gneiss*, which is said to have been the rock pierced from 1,600 to 1,810 feet.

BURRANBILLA BORE (Private).—Lat. 28° 20', Long. 145° 45'.

Depth, 1,811 feet; overflow per diem, 4,000,000 gallons; temperature, 124°.

If the measurements are correct, this bore has the largest amount of overflowing water of any in Queensland, and the water has the highest temperature.

TINNENBURRA BORES, Warrego River (Private).—Lat. 29°, Long. 145° 35'4

—					Depth.	Overflow per day.	Casing.	Rise over casing.
						Gallons.	Inches.	Inches.
No. 1†	...	...	...	...	1,250	500,000	8	4
” 2†	...	...	...	...	993	1,500,000	6	2.6
” 3†	...	...	...	...	1,293	250,000	6	0.2 or 3
” 4†	...	...	...	...	855	800,000	8	—5
” 5§	...	...	...	...	1,300			

NOORAMA BORES (Private).—Lat. 28° 20', Long. 146°.

No. 1 Bore. 1,502 feet deep; overflow, 1,500,000 gallons daily; temperature, 112°; pressure, 200 lb.

No. 2 Bore. 1,650 feet deep; overflow, 1,500,000 gallons daily.

No. 3 Bore. 1,632 feet deep; overflow, 3,456,000 gallons daily; temperature, 112°; pressure, 200 lb.†

Writing on 11th September, 1890, Mr. Henderson, in his “Annual Report for the Year ending 30th June,” adds to the paragraph on the Charleville Bore a footnote in the following terms, probably referring to the Noorama Bore:—“Since this was written it has been reported through a business house in this city that a bore in the Cunnamulla

\* Hydraulic Engineer's Report, 30th June, 1889.

† *Ibid.*, 30th June, 1891.

‡ Information furnished to Mr. McLennon, of the Hydraulic Engineer's Department by Mr. Joseph Pater.

§ “A good supply of fresh water. . . . remarkably hot.”—*Brisbane Courier*, 21st March, 1892.

district has very lately tapped a supply of nearly three and a-half millions of gallons per diem. The Ponce de Leon well at St. Augustine, Fla., U.S.A., has an estimated daily discharge of 10,000,000 gallons—doubtless U.S. gallons. The well is 1,400 feet deep by twelve inches diameter. The temperature of the water is 82° Fahr. This is the largest discharge of any well I know of.”

WEELAMURRA BORE (Private).—Lat. 28° 15', Long. 146° 15'.

Depth, 1,589 feet; water overflowing at the rate of 150,000 gallons per day; temperature, 113½°; pressure, 150 lb. to the square inch.\*

A newspaper report states that at five hundred and seventy feet, in black shale clay, the (No. 3?) bore struck alkaline water, which rose five hundred feet in the tubes.†

BURRENDILLA BORE, near Cunnamulla (Private).

Water overflowing at the rate of 2,500,000 gallons per day; depth not stated.‡

DILLALAH BORE, about fifteen miles from the Warrego.

Depth, 1,300 feet; water overflowing at the rate of 250,000 gallons per day. “Almost fresh and quite soft.”§

THARGOMINDAH BORE.

“Fresh water was struck at a depth of 1,100 feet, and the water has risen within one foot of the surface. Boring is being continued.”||

BARRINGUN, WARREGO RIVER (just across the New South Wales Border).

Water overflowing at the rate of about 25,000 gallons daily; still boring.¶

MALVERN HILLS BORE.

Depth, 2,800 feet; water struck at 1,300 feet, but did not rise to the surface.\*\*

KUNGIE LAKE BORE, forty-five miles south-west of Cunnamulla (Private).—Lat. 28° 40', Long. 145° 18'.

Depth, 1,255 feet; overflow, 500,000 gallons per day; temperature, 110°.

THURLAGOONA BORES (Private).—Lat. 28° 50', Long. 145° 30'.

No. 1. Depth, 1,270 feet; overflow, 177,000 gallons daily; temperature, 112°.

No. 2. Depth, 1,440 feet; yield per diem, 30,000 gallons ††; temperature, 102°.

No. 3. Depth, 1,616 feet; overflow per diem, 200,000 gallons; temperature, 108°.

No. 4. Depth, seven hundred and eighteen feet; yield per diem, 36,000 gallons ††; temperature, 102°.

No. 5. Depth, eight hundred and thirty-one feet; overflow per diem, 8,000 gallons.‡‡

No. 6. Depth, 1,529 feet; overflow per diem, 1,500,000 gallons; temperature, 108°.

CHARLOTTE PLAINS, near Cunnamulla.—Lat. 28° 20', Long. 146° 10'.

This Run is situated on Widgegoara Creek. Artesian water has been met with at 1,662 feet. The yield is 570,000 gallons per day.§§

\* Hydraulic Engineer's Report, 30th June, 1891.

† *Townsville Bulletin*, 21st December, 1888.

‡ *Brisbane Courier*, 25th June, 1891.

§ *Ibid.*, 2nd March, 1892.

|| *Ibid.*, 5th March, 1892.

¶ *Ibid.*, 24th March, 1892.

\*\* *Rockhampton Bulletin*, December, 1891.

†† Overflowing slightly; supply pumped.

‡‡ Salt water; overflowing when first tapped, but has since receded.

§§ *Sydney Evening News*, 10th April, 1891.

COONGALLA, near Cunnamulla.—Lat. 27° 45', Long. 145° 50'.

No. 1 Bore at 1,600 feet tapped water overflowing at the rate of 1,000,000 gallons per day.\*

No. 2 Bore "struck a good supply of beautiful water, estimated to yield 2,000,000 gallons daily, at a depth of 1,800 feet."†

CLAVERTON BORES, near Cunnamulla.

No. 1 Bore. Estimated yield, 3,000,000 gallons per day; depth not stated.‡

No. 2 Bore. Depth, 1,250 feet; water overflowing at the rate of 20,000 gallons per day.§ "Struck a big supply of fresh water on the 15th instant, the flow being estimated at 1,550,880 gallons daily, the pressure being 166 lb. to the square inch. The depth is 1,777 feet, and the supply is excellent."

BUNDILLA BORE, Bundilla Creek, Bingara Station, near Eulo (Private).

Water at 1,875 feet. "A good supply." Amount not stated. "The water is very hot, clear as crystal, and quite fresh."||

WHITULA, near Windorah.—Lat. 25° 20', Long. 142° 10'.

This bore has been carried to over 2,000 feet without success.¶

SANDRINGHAM BORE (Private).—Lat. 24° 25', Long. 138° 55'.

A newspaper report states that at Sandringham Station, on the Mulligan River, thirty-five miles west of Bedoworie Township, a supply of water overflowing at the rate of 40,000 gallons per day has been struck at the depth of one hundred and forty-three feet. Bedoworie is on Eyre's Creek, about fifteen miles north of its junction with King's Creek.

A second bore on Sandringham, between the Mulligan River and Sylvester Creek (Lat. 23° 30', Long. 138° 55'), has, I am informed by Mr. G. Neville Griffiths, been sunk between two springs to the depth of one hundred and sixty feet, and supplies 180,000 gallons of overflowing water daily.

BREADALBANE BORE.—Lat. 23° 50', Long. 139° 15'.

A bore is being sunk here near the "Three Sisters," twenty-seven miles up Cømerino Creek, Georgina River. The following section has been supplied by Mr. G. Neville Griffiths, the owner of the station:—

	Feet.
Clay, sand, and gravel drift (with traces of soda and gypsum)	30
Strong blue clay shale (brackish water) ... ..	30
Soft blue shale ... ..	16
" " (slightly different in texture) ... ..	34
Hard sandstone band ... ..	1
Blue shale ... ..	83
Hard sandstone band ... ..	1
Blue shale ... ..	168
(Strong flow of slightly brackish water, which rose to thirty feet from surface)	

\* *Brisbane Courier*, 1st October, 1891.

† *Ibid.*, 10th March, 1892.

‡ *Ibid.*, 12th November, 1891.

§ *Ibid.*, 18th February, 1892.

|| *Ibid.*, 15th December, 1891.

¶ *Ibid.*, 27th November, 1891.

	Feet.
Hard blue shale ... ..	36
Hard blue shale with black pebbles ... ..	2
Fine dark gritty sandstone... ..	3
(Brackish water cased off to this bed, and sweet water rises to six feet from surface)	

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 404

(Bore in progress).

There are no springs nearer than the Sylvester Springs, which are referred to under the head of Sandringham.

#### SOUTH AUSTRALIA.

Referring to the Rolling Downs Formation, as developed in South Australia, Mr. H. Y. L. Brown, Government Geologist for that Colony, says \* :—

“Below and surrounding the table-hills and stony downs are the soft silt plains, which, together with the former, cover the gypseous clays, marls, calcareous shales, limestone, sand, and gravel drifts of Cretaceous age. The greatest thickness of these beds, which has been proved by boring at Tarkininna, is about 1,200 feet. The mound springs, which are the natural indications of artesian water beneath these plains, are found in many places near the outcrops of bed rock, between the junction of which and the Cretaceous rocks the water has, doubtless, found an easier egress. On the surface the water often forms accumulations of travertine limestone, rising to heights of forty or fifty feet, and showing in the distance across the level plains, where there is a group of springs, like a low range of hills; the deposition of this limestone has, in many instances, formed raised cups or basins, over the edges of which the water flows. The water of these springs contains soda, and is generally good drinking water; in some cases, however, in the same group of springs, there is a great difference in the quality of the water, which in one spring may be drinkable, and in another, a few feet away, salt. As a rule these spring waters are warm, and must have a considerable temperature beneath the surface. Bores have been sunk by the Government in this formation at Tarkininna, where artesian water was tapped at 1,200 feet, and at Hergott, Coward Springs, Strangway Springs, &c., where a large supply of water was obtained at an average depth of some three hundred feet. The supply from some of these bores is over 1,000,000 gallons per day.”

J.

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\* The Mesozoic Plains of South Australia. *Proc. Austr. Assoc. Adv. Sci.*, i., 1888, p. 213.

## CHAPTER XXXII.

### THE ORGANIC REMAINS OF THE ROLLING DOWNS FORMATION

(LOWER CRETACEOUS).

WITH DESCRIPTIONS OF THE SPECIES.

"To draw a definite line between the Ipswich and the 'Rolling Downs' Bed is quite impracticable. The appearance of Belemnites and Ammonites generally marks the transition."\*

The physical aspect of the country produced by the former has been described by my Colleague, who states that the general absence of sections renders it impossible to subdivide this division, or to trace out definite horizons. He remarks—"We have a continuous series of beds of enormous thickness, in which, however, from the scarcity of sections, it would be impossible to map out horizons;" and that "the fossils from the Rolling Downs must be treated as a whole."† In the latter part of this paragraph I cordially agree, and have for some time past advocated classing the Rolling Downs Beds under the general term Cretaceous, admitting, however, at the same time that they contain an admixture of Oolitic as well as Cretaceous life. Even the late Charles Moore did not venture to introduce a geological sequence for the Queensland series, as he did for the Mesozoic Beds of Western Australia, but contented himself by remarking, "These and other circumstances indicate a higher horizon for the Queensland fossils." He appeared to think that the Oxford Clay put in a strong claim, but that "they all belong to the Upper Oolite may with safety be inferred."‡

I cannot do better than again quote my Colleague, who adds—"The fossils of the Rolling Downs Formation have given rise to much controversy among geologists and palæontologists, who have pronounced various localities, from limited collections, to be of ages ranging from Rhætic up to Lower Chalk. It is remarkable that almost every palæontologist who has worked on Queensland materials has come to the conclusion that fossils from different localities must have been mixed up, and this explanation has appeared to be specially necessary in the case of fossils from the Rolling Downs. On the other hand, my own explorations have satisfied me that Queensland fossils are not more liable to this kind of accident than fossils from other countries, and that the mixing up which has so annoyed palæontologists has been perpetrated by Nature herself."

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\* R. L. Jack, *Handbook Queensland Geology*, 1886, p. 65.

† *Ibid.*, p. 67.

‡ *Quart. Journ. Geol. Soc.*, 1870, xxvi., pp. 235 and 239.

## Kingdom—ANIMALIA.

## Sub-Kingdom—PROTOZOA.

## Class—RHIZOPODA.

## Order—FORAMINIFERA.

## Family—LAGENIDÆ.

Genus—CRISTELLARIA (*Lamarck*), *D'Orbigny*, 1826.

(Ann. Sci. Nat., vii., p. 290.)

CRISTELLARIA ACUTAURICULARIS, *Ficht.* and *Moll.*, var. LONGICOSTATA, *Moore*.*Cristellaria acutauricularis*, var. *longicostata*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., Pt. 2, p. 242.,, ,, var. *longicostata*, Eth. fil., Cat. Austr. Foss., 1878, p. 102 (*for synonymy*).*Sp. Char.* Shell oblong, moderately bi-convex, later chambers passing beyond helicoid portion; surface with ribs which are longitudinally costated. (*Moore*.)*Obs.* The typical European forms of *C. acutauricularis* which are found also with this shell possess smooth surfaces, and are without the longitudinal costæ—the difference being so marked as to justify its separation. (*Moore*.)*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).CRISTELLARIA CULTRATA, *Montfort*, var. RADIATA, *Moore*.*Cristellaria cultrata*, var. *radiata*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., Pt. 2, p. 242.,, ,, var. *radiata*, Eth. fil., Cat. Austr. Foss., 1878, p. 103 (*for synonymy*).*Obs.* This shell possesses the central disk of *C. cultrata*, from which the ribs on the surface proceed; and although the keel is less produced, there appears no doubt that it must be referred to this species. From the more radiating character of the costæ the varietal name of *C. radiata* was proposed. (*Moore*.)*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).Genus—DENTALINA, *D'Orbigny*, 1826.

(Ann. Sci. Nat., vii., p. 254.)

DENTALINA COMMUNIS, *D'Orbigny*.*Dentalina communis*, *D'Orb.*, Mém. Soc. Géol. France, 1840, iv., p. 13, t. 1, f. 4.

,, ,, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., Pt. 2, p. 239.

*Obs.* This species was recorded by the late Mr. Charles Moore without either description or observations.*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).Genus—VAGINULINA, *D'Orbigny*, 1826.

(Ann. Sci. Nat., vii., p. 257.)

VAGINULINA STRIATA, *D'Orb.**Vaginulina striata*, *D'Orb.*, Ann. Sci. Nat., 1826, vii., p. 257.

,, ,, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., Pt. 2, p. 239.

,, ,, Eth. fil., Cat. Austr. Foss., 1878, p. 104 (*for synonymy*).*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

**Genus—POLYMORPHINA, D'Orbigny, 1826.**

(Ann. Sci. Nat., vii., p. 265.)

**POLYMORPHINA GIBBA, D'Orb., sp.***Globulina gibba*, D'Orb., Ann. Sci. Nat., 1826, vii., p. 266.*Polymorphina gibba*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., Pt. 2, p. 239.

" " Eth. fil., Cat. Austr. Foss., 1878, p. 104 (for synonymy).

*Loc.* Wollumbilla (The late Rev. W. B. Clarke).**POLYMORPHINA LACTEA, Walker and Jacob, sp.***Polymorphina lactea*, Parker and Jones, Ann. and Mag. Nat. Hist., 1859, iv., pp. 336 and 341.

" " Moore, Quart. Journ. Geol. Soc., 1870, xxvii., Pt. 2, p. 239.

" " Etheridge fil., Cat. Austr. Foss., 1878, p. 104 (for synonymy).

*Loc.* Wollumbilla (The late Rev. W. B. Clarke).**Family—ROTALIDÆ.****Genus—PLANORBULINA, D'Orbigny, 1826.**

(Ann. Sci. Nat., vii., p. 280.)

**PLANORBULINA LOBATULA, D'Orb., sp.***Truncatulina lobatula*, D'Orb., Foram. Foss. Tert. Vien., 1846, p. 163, t. 9, f. 18-23.*Planorbulina lobatula*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., Pt. 2, p. 239.

" " Eth. fil., Cat. Austr. Foss., 1878, p. 103 (for synonymy).

*Obs.* No remarks were made on this species by Mr. Moore.*Loc.* Wollumbilla (The late Rev. W. B. Clarke).**PLANORBULINA UNGERIANA, D'Orbigny, sp.***Rotalia ungeriana*, D'Orb., Foram. Foss. Tert. Vien., 1846, p. 159, t. 8, f. 16-18.*Planorbulina ungeriana*, Moore, Quart. Journ. Geol. Soc., 1870, xxvii., Pt. 2, p. 239.

" " Eth. fil., Cat. Austr. Foss., 1878, p. 104 (for synonymy).

*Obs.* Like the two last, this is only a list species.*Loc.* Wollumbilla (The late Rev. W. B. Clarke).**Class—SPONGIDA.\*****Order—SILICISPONGIA.****Sub-Order—HEXACTINELLIDÆ.****Group—LYSSAKINA.****Genus—PURISIPHONIA, Bowerbank, 1869.†***Purisiphonia*, Bowerbank, Proc. Zool. Soc., 1869, p. 342.

" Bowerbank, in Moore, Quart. Journ. Geol. Soc., 1870, xxvi. p. 240.

" Carter, Ann. and Mag. Nat. Hist., 1878, i., p. 376.

" Zittel, Handb. Pal., 1876, i., p. 179.

" *Gen. Char.* The form of the entire sponge is unknown. Judging from the portions preserved, it appears to have consisted of a hollow stem giving off tubular branches. The walls are thick and robust, and the outer surface slightly uneven.

\* The present article on *Purisiphonia* has been kindly contributed by Dr. George Jennings Hinde, from specimens in the Natural History, Museum, London. It is given verbatim in his own words.

† Emend. Hinde, 1892.



"The wall of the sponge is traversed by numerous canals, which open on both sides of the wall, and extend inwards, either at right angles or obliquely to the surface of the sponge. The canals bifurcate or branch within the wall; they do not penetrate through it, but terminate just below the opposite surface to that on which their oscules open. There is no definite arrangement in the course of the canals, which occasionally appear to anastomose within the wall. The canals are evenly bounded by the ordinary spicular tissue, and do not possess a special lining. The oscular apertures are either circular, elliptical, or trumpet-shaped, and in some instances divided by the extension over them of the spicular fascicles.

"The skeletal mesh composing the substance of the sponge-wall is close, resistant, and intricate. It consists of slender fascicles or bundles of straight, elongate, linear spicules, disposed parallel with each other, and united together by a common coating of silica throughout the greater part of their length. These spicular fascicles have no definite arrangement; they overlap each other in different directions, though for the most part they are generally parallel with the sponge-wall. They are more abundant on the exterior surfaces, though they also traverse the interior of the wall in various directions. Between these fascicles there are rod-like spicules, either nearly parallel with each other or disposed irregularly, crossing and intercrossing each other in all directions. At their points of contact these spicules are definitely fused together, and they are further united by the development of short transverse rods and siliceous processes which connect adjoining spicules, and thus form a strong and complex spicular mesh-work with irregular interspaces. Here and there in the interspaces of the mesh are solitary regular hexactinellid spicules, their rays being fused with the adjacent mesh-work, and in many places also there are small groups of minute regular hexactinellid spicules, intermingled closely together without any order, and their rays fused at the points of contact with each other.

"There is no apparent specialised dermal layer. On both surfaces of the sponge-wall the spicular fascicles extend over the oscular vents, and the spaces between the fascicles exhibit much the same spicular character as the interior of the wall. Further, the canals are not lined by any distinctive spicular tissue.

*Obs.* "Mr. H. J. Carter has truly remarked of this genus that its minute spicular structure is totally different from that of any other hexactinellid sponge. Its peculiar characters render its relationship somewhat doubtful. At first sight, indeed, one would hardly recognise it as a hexactinellid sponge, since only the fascicles of linear spicules are exposed on its surface, and the intermediate scaliform or irregular spicular tissue more resembles a combination of monactinellid than hexactinellid spicules. The presence, however, of definite six-rayed hexactinellid spicules, either singly or forming small groups in the interspaces of the mesh-work, at once determines its relations to this order. Its position within the order is less easy to define. The entire absence of any regular arrangement of the spicular mesh, or of any regular tissue formed by the fusion of the rays of regular hexactinellid spicules with the corresponding rays of adjacent spicules, removes the genus from the Dictyonine Group of the Hexactinellidæ. The definite fusion of the spicular rays with each other, thus binding them firmly together, is, on the other hand, a character which would tend to exclude this genus from the Lyssakine Group, in which, as a rule, the spicules are only held in position by the soft animal structures of the sponge. Notwithstanding this fact, the general spicular characters of *Purisiphonia* appear to me to indicate a closer relationship to the Lyssakina than to the Dictyonina.

"Thus the fascicles of spicular rods may be compared with those of the existing genus *Euplectella*, Owen, though they are not continuous as in the recent form, and a

further resemblance is shown in the fact that in this recent genus also the linear and other spicules are partially united in an irregular manner by transverse bulks and siliceous extensions as in *Purisiphonia*. Likewise in the existing genera, *Hertwigia*, O. Schmidt, and *Rhabdoplectella*, O. Schmidt, the skeletal spicules are firmly cemented together in the lower portion, whilst they are free in the upper portion of the sponge, thus exhibiting, as Oscar Schmidt remarks,\* transitional characters between the *Lyssakina* and *Dictyonina*. These recent genera have been, however, ranked with the *Lyssakina* Group, and, considering the nature of the spicules in *Purisiphonia*, it should, in my opinion, also be placed in the same group. In its massive wall of closely arranged spicular fibres, all firmly and irregularly cemented together, and penetrated by definitely bounded branching canals, this genus is very distinctly marked off from any other Hexactinellid, whether fossil or recent.

*PURISIPHONIA CLARKEI*, Bowerbank, Pl. 19.

- Purisiphonia Clarkei*; Bowerbank, Proc. Zool. Soc., 1869, p. 342, Pl. xxv., figs. 6 and 7.  
 " " Moore, Quart. Journ. Geol. Soc., 1870, xxvi., pp. 235, 240, Pl. xvii., fig. 1.  
 " " Sollas, Quart. Journ. Geol. Soc., 1877, xxxiii., p. 802.  
 " " Carter, Ann. and Mag. Nat. Hist., 1878, i., p. 376.  
 " " Zittel, Handb. Pal., 1878, i., p. 179.  
 " " Eth. fil., Cat. Austr. Foss., 1878, p. 104.  
 " " Hinde, Cat. Foss. Sponges Brit. Mus., 1883, p. 124.  
 " " Vosmaer, Bronn's Klassen und Ordnungen des Thier-Reichs, 1885, 2 er. Bd. (Porifera), p. 266.

"*Sp. Char.* The largest fragment of this species which has yet been discovered is apparently the main tubular stem of an individual with the bases of two or three branches. The fragment is about one hundred mm. in length and breadth, and the walls are about fifteen mm. in thickness.

"The oscules are numerous, disposed without regular arrangement, from one to two mm. apart, and varying from one to three mm. in diameter. The canals very slightly diminish in their course in the wall until they bifurcate.

"The spicular fascicles of the skeleton are about twelve mm. in length and from fifteen to twenty-five mm. in thickness, the linear spicules composing them, about nine or ten in number, are in close contact and so united by silica that the compound character of the bundle can in some cases only be clearly seen by the axial canals of the spicules (Pl. 19, fig. 6). The linear spicules, not in fascicles, are, as a rule, much stouter than those forming the fascicles; the connecting transverse processes are numerous, and so bridge over the spaces between the spicules that but little more than oval or circular fenestræ exist between them. Though, as a rule, these connecting bulks are stouter than the spicules, there are no canals present in them, whereas they can be traced in most of the linear spicules. The groups of minute normal hexactinellid spicules appear to be very irregular in their distribution; in some instances they are massed near the terminations of the canals. Their rays appear to be sub-equal, cylindrical, or tapering but very slightly and with rounded ends. The rays vary from .1 to .13 mm. in length, and .02 mm. in thickness. These spicules, as shown in the figure (Pl. 19, fig. 10), are very indiscriminately mingled together, and their rays are fused wherever they are in contact with others.

*Obs.* "This species was first described and figured by Dr. Bowerbank, who received the specimens from Mr. Charles Moore. He constituted for them the genus *Purisiphonia*, a rather inappropriate name, since it might be thought to indicate a connection with the Lithistid genus *Siphonia*, with which this form has nothing in common.

\* Die Spongien des Meerbusen von Mexico, 2te. Abth., pp. 42 and 62.

Subsequently Mr. C. Moore figured the largest specimen in the Quarterly Journal of the Geological Society, and reprinted the description of Bowerbank. Eight years later Mr. H. J. Carter, F.R.S., gave an emended description of the species, pointing out its particular features in a much clearer manner than had been done originally. Mr. Carter compared the form with the existing *Dactylocalyx pumicens*, Stutchbury, and with *Euplectella aspergillum*. He also made the rare discovery of one of the flesh spicules, a globular rosette, with radiating capitate rays about  $\frac{1}{3000}$  inch in diameter (Pl. 19, fig. 11). Following Mr. Carter's description, Prof. Zittel gave a diagnosis of the genus, and placed it as a Dictyonine Hexactinellid in the family Staurodermidæ. The character of its spicular structures generally, and the absence of hexactinellid spicules in the dermal layer of both surfaces of the wall, show, however, that it cannot definitely remain in this family.

"The example in the British Museum, which is the typical form studied by Dr. Bowerbank, is about fifty mm. in length and the same in breadth. It has been imbedded in a calcareous matrix, which has been removed by acid, and the internal structure is as clearly shown as in a recent sponge. The spicular skeleton is of a whitish-grey tint by reflected, and transparent by transmitted light; between crossed nicols the silica gives the tints of chalcedony. The axial canals of the spicules are now infilled with a lightish brown, apparently earthy material.

"No other species of the genus has yet been discovered."

Loc. Wollumbilla (*The late Rev. W. B. Clarke*).

## Sub-Kingdom—ECHINODERMATA.

### Section—PELMATOZOA.

#### Class—CRINOIDEA.

#### Order—ARTICULATA.

#### Family—PENTACRINIDÆ.

*Genus*—*PENTACRINUS*, *Miller*, 1821.\*

(*Nat. Hist. Crinoidea*, p. 45.)

*PENTACRINUS AUSTRALIS*, *Moore*, Pl. 20, f. 1-3.

*Pentacrinus australis*, *Moore*, Quart. Journ. Geol. Soc., 1870, xxvi., p. 243, t. 17, f. 3, t. 18, f. 1.

*Sp. Char.* Pelvis short, compressed, rounded; plates of the body and arms finely rugose; scapulæ thick, supporting ten arms, composed of thirteen plates, the hands bifurcating from cuneiform joints, the fingers being of considerable length, with forty or more joints of varying thickness, to which are attached lengthened, jointed tentacles. Interior of the pelvis disk-like or concave, exhibiting a central pit. (*Moore*.)

*Obs.* Two specimens of this fine and interesting species are from the Mitchell Downs, on the Amby River; and it is seen by the numerous arms that pass through the block of limestone that a whole colony of them must have been present. One of the specimens is lying on its side (exhibiting the base of the pelvis with its columnar articulation), whilst three arms, with the bases of two others, are exhibited. The second specimen shows the interior of the pelvis, and has arms flattened out. Each arm, above the scapulæ, appears to have been about six inches in length. In a block from Wollumbilla a portion of a column, with ninety-five regular joints, is present, of

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\* Emend. P. H. Carpenter.

probably the same species. Unfortunately, some of the connecting joints of the arms have been washed out, though the impressions are left indicating their direction. (Moore.)

The presence of Pentacrinoid remains in the Wollumbilla blocks was first pointed out by Prof. McCoy,\* in a collection from that locality, submitted to him by the late Rev. W. B. Clarke.

My late friend, Dr. P. H. Carpenter, was kind enough to review this species, in company with M. de Loriol. It became a question whether it really is a *Pentacrinus*, or only one of the Comatulæ. Dr. Carpenter wrote: "We both agree that the form had better retain its generic name *Pentacrinus* till something more is known about it. He [M. de Loriol] is struck, as I am, by the absence of any reference to stem fragments in the two blocks containing the specimens; and we both feel it to be quite possible that they are Comatulæ. In any case there is a much larger number of joints (distichals) before the first axillary of the arms than in any recent Comatulæ, which never have more than four distichals, whilst there must have been fourteen or fifteen in *P. australis*. I do not know of any recent *Pentacrinus* with more than seven, though it may run to seventeen in the fossil species, and to twelve in *Extracrinus*, and in the recent *Metacrinus*. But it certainly belongs to neither of the latter genera."

Loc. Mitchell Downs, Amby River; and Wollumbilla (The late Rev. W. B. Clarke).

## Sub-Kingdom—ANNULOSA.

Class—ANNELIDA.

Order—TUBICOLA.

Family—SERPULIDÆ.

Genus—*SERPULA*, Linnaeus, 1758.

(Systema, Edit. x., p. 786.)

*SERPULA INTESTINALIS*, Phillips.

*Serpula intestinalis*, Phillips, Ill. Geol. Yorksh., 1836, Pt. i, p. 138, t. 5, f. 21.

" " Moore, Quart. Journ. Geol. Soc., 1870, xxvi., Pt. 2, p. 239.

Obs. This species is recorded by the late Mr. Charles Moore without description or other reference. It is characteristic of the Oxford Clay and Cornbrash.

Loc. Wollumbilla (The late Rev. W. B. Clarke).

Class—CRUSTACEA.

Order—CIRRIPEDIA.

Obs. The presence of Crustacea in the Upper Mesozoic rocks of Queensland is at present not definitely recorded. The only evidence of their existence lies in the following passage by Mr. Moore†:—

"When the tests of the Australian shells are occasionally broken, or casts only are preserved, it may be often noticed that the interiors were covered by Polyzoa, Serpulæ, and other parasitic animals. On the interior of *Panopæa* are two disk-like impressions with fimbriated radiating surfaces; and it was difficult to decide whether they might not be flattened corals, or even *Crania*. On consulting my friend, Mr. Etheridge,‡ respecting them, he suggested that they might be the places of attachment

\* Trans. R. Soc. Vict., 1865, vi., p. 44.

† Now, of course, the rediscovery of Mr. Norman Taylor's Crustacean invalidates this statement. (R.E. Junr.)

‡ Mr. R. Etheridge, F.R.S.

of *Balani* or some other Cirripeds; and on examining the collection at Jermyn Street,\* analogous impressions were found, produced by the attachment of these shells; so that, although no other traces of the shells have been found, the family may, I think, be added to the list."

### Class—INSECTA.

### Order—NEUROPTERA.

### Family—LIBELLULINÆ.

Genus—*AESCHNA*, *Fabricius*, 1776.

(Gen. Insectorum, p. 147.)

*AESCHNA FLINDERSSENSIS*, *H. Woodward*, Pl. 20, fig. 4.

*Aeschna flindersensis*, *H. Woodw.*, *Geol. Mag.*, 1881, i., p. 339, t. 11, f. 1.

*Obs.* The first Insect discovered in Australian Mesozoic rocks has been described under the above name by Dr. Henry Woodward. It was found by my Colleague in 1881. The remains consist of the proximal half of the posterior wing of a Libelluloid Insect, and exhibit the nervures in a remarkably fine state of preservation. As preserved, the portion measured twenty-five mm. in length, and nearly fifteen mm. in depth, and when perfect was probably forty-five mm. in total length. Dr. Woodward remarks—"It is the posterior wing of a Neuropterous Insect of the sub-order Odonata, Fabr., and perhaps referable to the sub-family Gomphinae, one genus of which, *Austrogomphus*, de Selys, having five species, is characteristic of Australia and Tasmania."

It is very closely allied to forms met with in the Lower Secondary rocks of England—viz., the Purbeck Beds of Dorsetshire.

*Loc.* Flinders River, seven miles above Marathon Station (*R. L. Jack*). Since the discovery of the above, Mr. J. H. Simmonds has found Insect remains in the Ipswich Coal Measures.

### Sub-Kingdom—MOLLUSCA.

### Section—MOLLUSCOIDA.

### Class—POLYZOA.

### Order—GYMNOLEMATA.

### Family—ESCHARIDÆ.

Genus—*LEPRALIA*, *Johnston*, 1838.

(*Hist. Brit. Zoophytes*, p. 277.)

*LEPRALIA* ? *oolitica*, *Moore*, Pl. 20, figs. 5 and 6.

*Lepralia oolitica*, *Moore*, *Quart. Journ. Geol. Soc.*, 1870, xxvii., p. 243, t. 17, f. 2.

*Sp. Char.* Cells long, cylindrical, base soon becoming immersed, so as to resemble *Tubulipora* or *Diastopora*. (*Moore*.)

*Obs.* Prof. G. Busk, who examined the species, remarked that he had not before noticed it, and that it did not occur in a series (Tertiary) he had examined from Mount Gambier. The genus has not hitherto been found lower than the Cretaceous Period. It occurs not unfrequently on the exteriors of the Wollumbilla fossils. (*Moore*.)

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\* The Museum of Practical Geology, Jermyn Street, London. (*R.E. Junr.*)

On the subject of the Class Polyzoa generally, Moore made the following remarks:—"It is not improbable that this group may be numerously represented, as there are frequent indications of Polyzoa; but the worn condition of many of the shells to which they are attached is unfavourable to their preservation. On a cast of a *Cytherea* from the Maranoa River numerous reticulated impressions show that its interior was almost covered with them."

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

## Class—BRACHIOPODA.

### Order—TRETENTERATA.

#### Family—TEREBRATULIDÆ.

*Genus*—*TEREBRATELLA*, *D'Orbigny*, 1847.

(*Comptes Rendus*, xxv., p. 269.)

*TEREBRATELLA DAVIDSONII*, *Moore*, Pl. 20, figs. 7 and 8.

*Terebratella Davidsonii*, *Moore*, Quart. Journ. Geol. Soc., 1870, xxvi., p. 245, t. 10, f. 1 and 2.

*Sp. Char.* Shell rather large, transversely ovate or subtrigonal, slightly convex; beak truncated; ventral area extended and slightly depressed below a lengthened, slightly rounded hinge-line. The surface of the valves exhibits distinct but very minute punctations, and possesses wide concentric bands, on which are regular but much finer lines of growth; these are crossed by numerous radiating striæ, which, towards the margins of the folds, give the shell a fimbriated appearance, very fine plicæ being visible on the whole of the surface. The larger or dorsal valve possesses a wide mesial fold, with a corresponding sinus on the ventral valve. (*Moore*.)

*Obs.* Three examples of this very pretty species occur, but only one is free from the matrix and tolerably perfect, and, to all appearance, belonging to *Terebratella*, under which genus (in the absence of internal structure) it is placed. It is the largest of the Australian Brachiopoda, and I have named it *T. Davidsonii*, after the Palæontologist who has spent a life in the elucidation of this important group. (*Moore*.) In another specimen, collected by Mr. Sweet, the fold is very flat, and hardly perceptible.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*; *G. Sweet*—Colln. Sweet, Melbourne).

#### Family—THECIDEIDÆ.

*Genus*—*ARGIOPE*, *Deslonchamps*, 1842.

(*Mém. Soc. Linn. Normandie*, vii., p. ix.)

*ARGIOPE ? WOLLUMBILLENSIS*, *Moore*, Pl. 20, figs. 9-11.

*Argiope wollumbillensis*, *Moore*, Quart. Journ. Geol. Soc., 1870, xxvi., Pt. 2, p. 243, t. 10, f. 3-5.

*Sp. Char.* Shell compressed, transverse; hinge-line extending the entire length of the shell; umbones depressed; ventral area extended; deltidium narrow, triangular; exterior of the valves covered with coarse rounded striæ, which are broken at the concentric lines of growth, where they are seen to be hollow, and were probably continued in spines over the folds of the shell; exterior of dorsal valve abruptly keeled, the lines of growth crossing, which give the keel a comb-like appearance; interior of the dorsal valve with a sinus, which terminates at the front of the shell in a deep fold, and it possesses teeth-sockets, cardinal process, and distinctly raised crural plates; ventral valve, in its younger state, rather flat, but becomes concave and closely fitting

to the dorsal valve; it possesses a deep sinus corresponding to the depression in the interior of the large valves; edges of the shell closely fitting; internal loop not known. Shell structure very finely punctate. (*Moore.*)

*Obs.* This interesting shell is found with the *Purisiphonia* and other remains at Wollumbilla, and as there are evidences of several more or less perfect examples in the block, it must be an abundant shell. It belongs to the group originally arranged by Dr. E. Deslonchamps under *Argiope*, of which he described three species from the Lias, but which in his "Palaeontologie Française" he subsequently removed to *Terebratula*. Having found the same species at Whatley, and referred them to *Argiope*, I think it convenient still to retain them in this group, though ultimately it is probable they may have to be separated from it and constituted a sub-genus. At present little is known of their loops or internal characters. The Australian examples are more regularly striate than the European Liassic species. Where the striæ on the *A. wollumbillænsis* are occasionally abraded, a canal is visible, which leads me to suspect they were originally hollow, and probably continued in spines beyond the shell, like those on *Athyris* or *Spirifera rostrata*. In its outer form this shell very much resembles some of the Strophomenidæ. (*Moore.*)

In another portion of his Paper Mr. Moore again remarked—"The peculiar form of these shells, their long hinge-lines, compressed valves, and finely folded or plicated exteriors, even in ignorance of the internal form of the loop, are, I think, sufficient to justify their arrangement eventually under a new genus or sub-genus."

In Mr. Sweet's example the fold and sinus are very marked features. The exterior of the shell was rugged.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke; G. Sweet*—Colln. Sweet, Melbourne).

#### ARGIOPE? PUNCTATA, *Moore*, Pl. 20, fig. 12.

*Argiope punctata*, *Moore*, Quart. Journ. Geol. Soc., 1870, xxvi., Pt. 2, p. 244, t. 10, f. 6.

*Sp. Char.* Shell small, transversely ovate; dorsal valve flattened or slightly convex; margins regularly rounded; surface of valve with bifurcating longitudinal striæ, which at the front are thirty in number. (*Moore.*)

*Obs.* This shell clearly indicates the presence of a second species of the group. Only one valve is known, and this is not perfect. The striæ are much more distant, and stand up in sharp ridges, and the punctations are much coarser and fewer than on the *A. wollumbillænsis*. In these respects the species approaches nearer to the French and English examples. The specimen is attached to the surface of a *Serpula intestinalis*. (*Moore.*)

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

#### Family—RHYNCHONELLIDÆ.

*Genus*—*RHYNCHONELLA*, *Fischer*, 1809.

(Notice Foss. Gouv. Moscou, p. 35.)

#### *RHYNCHONELLA RUSTICA*, *Moore*, Pl. 20, fig. 13.

*Rhynchonella rustica*, *Moore*, Quart. Journ. Geol. Soc., 1870, xxvi., Pt. 2, p. 245, t. 10, f. 7-9.

*Sp. Char.* Shell variable, usually wider than long, beak acute; when young compressed, with both valves slightly convex, without sinus, and margins rounded; with age the shell is furnished with a broad sinus in the ventral, with a corresponding convexity or mesial fold in the dorsal valve; surface covered with striæ, from twenty to twenty-five in number, which in the adult shell are somewhat wavy or irregular. (*Moore.*)

*Obs.* With age the dorsal valve becomes very convex, and the frontal margin considerably thickened. It approaches most closely to the *B. concinna* of the Great Oolite and Bradford Clay, but in its general aspect it is a coarser shell, and the plicæ are more irregular. I have seen about twenty examples, so that it must be very abundant. In the hollows of the striæ are occasionally Polyzoa and attached Foraminifera. (*Moore.*)

*Loc.* Wollumbilla District (*The late Rev. W. B. Clarke.*)

**RHYNCHONELLA SOLITARIA, Moore, Pl. 20, fig. 19.**

*Rhynchonella solitaria*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., Pt. 2, p. 245, t. 10, f. 10.

*Sp. Char.* Shell wider than long; ventral valve with broad mesial sinus, in which are four widely spreading costæ, with a single lateral costa on either side of the sinus. Towards the umbo the shell is smooth, and without appearance of costæ. (*Moore.*)

*Obs.* Only a single specimen of a ventral valve of this species occurred in one of the Wollumbilla blocks and it was not quite perfect.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke.*)

## Order—CLISTENTERATA.

### Family—DISCINIDÆ.

*Genus*—*DISCINA*, Lamarck, 1819.

(Hist. Nat. Anim. sans Vertéb. vi., Pt. 1, p. 236.)

*DISCINA APICALIS*, Moore, Pl. 20, fig. 15.

*Discina apicalis*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., Pt. 2, p. 244, t. 10, f. 13.

*Sp. Char.* Shell small, round, or slightly ovate; apex very acute, almost central, or inclined to anterior end; shell-structure thin, with faint concentric lines of growth. (*Moore.*)

*Obs.* Only a single, somewhat imperfect, example of this shell was seen. Its chief peculiarity appears to be its very high and conical figure in proportion to its size. (*Moore.*)

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke.*)

### Family—LINGULIDÆ.

*Genus*—*LINGULA*, Bruguière, 1778.

(Encyclop. Methodique, i., Pl. 250, f. 1.)

*LINGULA OVALIS*, J. Sowerby, Pl. 20, fig. 14.

*Lingula ovalis*, J. Sby., Min. Con. i., p. 56, t. 19, f. 4.

„ „ Moore, Quart. Journ. Geol. Soc., 1870, xxvi., Pt. 2, pp. 236 and 240.

*Obs.* The only species to be recognised amongst the Wollumbilla fossils is the *Lingula oralis* of the Kimmeridge Clay, or the *L. subovalis* of the Lower Greensand, which names probably refer to the same species. This shell is most abundant, as many as fifteen examples being visible on the surfaces of a block only two or three inches square. Its presence assists in uniting the faunæ in several of the blocks which contain nothing else in common. (*Moore.*)

It is very questionable if this be the species figured by Davidson under this name. Tate has adopted for it the name of *L. subovalis*.\*

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke.*)

\* Proc. Austr. Assoc. Adv. Sci. for 1838 [1889], i. p. 230.



## Section—MOLLUSCA VERA.

## Class—PELECYPODA.

## Order—OSTRACEA.

## Family—OSTREIDÆ.

Genus—*OSTREA*, *Linnaeus*, 1758.

(Systema, Ed. x., p. 696.)

*OSTREA VESICULOSA*, *J. Sowerby*, sp., Pl. 21, figs. 1-3.*Gryphæa vesiculosa*, *J. Sby.*, Min. Con., 1822, iv., p. 93, t. 369.*Ostrea vesiculosa*, *Coquand*, Mon. Ostrea, 1869, p. 152, Atlas, t. 59, f. 4-7.,, ,, *Pictet and Campiche*, Descrip. Foss. Terr. Crét. Env. St. Croix, 1871, 4c Pt., p. 311, t. 194, f. 1-6.

*Obs.* Three individuals of this characteristic and widely distributed shell have been obtained in Queensland. They correspond in general characters with the excellent figures by MM. Pictet and Campiche, of their specimens from the Upper Gault of St. Croix.

*Loc.* Gypsum Mine, Chollarton (*Hon. A. C. Gregory*).

## Family—PECTINIDÆ.

Genus—*PECTEN*, *O. F. Müller*, 1776.

(Zool. Danicæ Prod., p. xxxi.)

*PECTEN MOOREI*, sp. nov., Pl. 21, fig. 20.*Pecten fimbriatus*, *Moore*, Quart. Journ. Geol. Soc., 1870, xxvi., p. 248, t. 11, f. 8.

*Sp. Char.* Shell rather convex, with numerous longitudinal slightly nodulated costæ at the front of the shell, and, continuing to about the middle, where they die out, are faint intermediate striæ. These are crossed by regular concentric fimbriated striæ, which in the interspaces are produced beyond the shell.

*Obs.* The name assigned to this species by Mr. Moore was preoccupied by Philippi\* for a Sicilian Tertiary species. Under these circumstances, the foregoing designation may be accepted in its place, with the view of avoiding confusion.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

*PECTEN ŒQUILINEATUS*, *Moore*, Pl. 21, fig. 10 (? fig. 8).*Pecten? œquilineatus*, *Moore*, Quart. Journ. Geol. Soc., 1870, xxvi., p. 248, t. 11, f. 11.

*Sp. Char.* Shell ovately orbicular, moderately convex; surface covered with numerous raised divergent longitudinal striæ, crossed by about the same number of equally raised concentric costæ, which narrow towards the apex, where, decussating the longitudinal striæ, they present small folds or punctate-looking bosses; interstitial spaces smooth, auricles large, unequal. (*Moore*.)

*Obs.* This shell approaches nearest in ornamentation to the *P. retiferus* of the Great Oolite, but it has a much larger number of concentric costæ, and is much more delicately marked than that shell. Several ill-preserved valves have been observed in the various collections examined, which may perhaps be referred to this species. A specimen of this description is figured (Pl. 21, fig. 8).

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*). ? *Aramac* (Pl. 21, fig. 8).

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\* Enum. Moll. Siciliæ, 1844, ii., p. 61.

PECTEN SOCIALIS, Moore, Pl. 21, figs. 6, 7 (? 5 and 9).

*Pecten socialis*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 248, t. 11, f. 10.

[Compare *Pecten psila*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., p. 239.]

*Sp. Char.* Shell suborbicular, small, both valves apparently alike, moderately convex, margins rounded. Dorsal margin short, shortest on the anterior side. Umbones rather gibbous, pointed; ears small, triangular, flattened, the anterior the smaller of the two, apparently unornamented; anterior and posterior slopes well marked. Surface with very regular radiately curved striæ, with four or five strong concentric undulations on the umbonal region.

*Obs.* The late Mr. Tenison Woods suggested that his *Pecten psila* might be this species, and Prof. Tate has adopted \* this view, but if the ears of Woods' species are, as he describes them, radiately ribbed, the two shells cannot be identical. The curved radiating and very fine costæ place *P. socialis* near the genus *Camptonectes*, Agassiz, but I have not seen any evidence of the existence of the intercostal punctæ. It reaches as much as one inch in length by a half-inch in breadth, a shell of this size being in the cabinet of Mr. George Sweet, and the specimen figured by Moore seems to have been of similar dimensions.

In general appearance *P. socialis* would also seem to fall within Meek's genus *Syncyclonema*,† which was proposed for smooth compressed Pectens of Cretaceous and Jurassic rocks, such as "cannot be properly included in the genus *Pecten* as restricted to such forms as *P. maximus*." It is a compressed, nearly equivalve closed genus, with a short hinge-line, small ears, and no definite byssal sinus. Mr. Moore made the following remarks on his Wollumbilla specimen:—"The external ornamentation of this shell is not well preserved; but it appears to have been nearly smooth, without visible concentric striæ, but with depressed radiating ribs. In general form it is not unlike *P. rigidus*.‡ It is one of the most abundant shells in the boulders from Wollumbilla, many specimens of all ages appearing on their fractured surfaces."

In Pl. 21, fig. 5, a very small, imperfect, and apparently quite smooth *Pecten* is figured, but without other distinctive features than its form. The interior of the valve only is seen. The posterior wing was very small, and obliquely rectangular, the anterior somewhat larger, with a slight byssal notch below it. The hinge-line was straight. This little fossil is perhaps related to the present species.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*; *G. Sweet*—Colln. Sweet, Melbourne); Walsh River (*Hon. A. C. Gregory*); Pl. 21, fig. 5, Mitchell Railway Station (*J. Falconer*).

PECTEN, *sp. ind.*, Pl. 21, figs. 7 and 9.

*Obs.* A small and apparently common *Pecten*, of which the exterior has not been seen, in some of its characters resembles *P. socialis*, but departs from it in the relative size of the more or less flattened ears. The shells are suborbicular, with square flattened ears and a shallow triangular cartilage pit. The interior surface is smooth, but the shell is thin enough to show radiating striæ, which become stronger towards the ventral and lateral margins. They have much the appearance of the punctured radiations seen in the genus *Camptonectes*, and divaricate rather than radiate in a similar manner. The body of the shell appears to bear a series of concentric laminæ (Pl. 21, fig. 7). The points mentioned are clearly important features of the species, and it is

\* Proc. Austr. Assoc. Adv. Sci. for 1888 [1889], i., p. 230.

† Smithsonian Check-list of N. American Cret. Foss., 1864, p. 7; also Report U. S. Geol. Survey, Territories, 1876, ix., p. 26.

‡ J. Sowerby, Min. Con., iii., p. 5, t. 205.

to be regretted that no exteriors have been seen. There is a general resemblance to Moore's *P. socialis*, but the details of the latter are so little known that a satisfactory comparison cannot be made.

*Loc.* Aramac (*The late J. Smith*); Rockwood Station, Landsborough River (*R. L. Jack*).

*Genus*—*AMUSIUM*, Klein, 1753.

(Tent. Meth. Ostr.)

*AMUSIUM*, *sp. ind.*, Pl. 21, figs. 4 and 4a.

[Compare *Amusium sulcatellum*, Stoliczka, Pal. Indica, 1871, iii., Pts. 9-13, p. 436, t. 31, figs. 12, 12a, and 17.]

*Obs.* We have but the ears and umbonal portion of a single valve to represent this genus. It has a general resemblance to the above species, but the apical angle differs. The hinge-line is not quite horizontal, but has an inclination to an upward deflection after the manner of the genus *Entolium*. The surface of the valve is a good deal decorticated, but there are traces of fine regular concentric lines, as shown in the enlarged figure. The umbo was small and acute.

*Loc.* Rockwood Station, Landsborough River (*R. L. Jack*).

Family—LIMIDÆ.

*Genus*—*LIMA*, Bruguière, 1789.

(Tab. Encycl. Méthod., Pl. 206.)

*LIMA GORDONI*, Moore, Pl. 24, fig. 16.

*Lima Gordoni*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 247, t. 12, f. 4.

*Sp. Char.* Shell ovately oblong, inequilateral, oblique, thin, with about fifteen to seventeen rounded costæ, which become obsolete on the posterior side, and with many concentric close-set but distinct lines of growth; hinge-line narrow and straight, posterior side rounded, anterior oblique; ventral margin rounded. (*Moore*.)

*Obs.* Casts of this species are stated to be common. In critically examining *Lima Gordoni*, comparison should be made with *Lima wacoensis*, F. Roemer,\* from the Chalk of Texas, which is very close to the present species, and appears to be intermediate between it and *Lima Randsi*. In the Texan fossil the ears are small and plain without costæ, whilst the costæ on the body of the shell are simple with very few exceptions.

Another species to which the present is allied is *Lima alternans*, F. A. Roemer,† of the North German Oolite, but the ribs are less in number than in the former. Amongst British species *Lima Gordoni* is related to *Lima semicircularis*, Goldf., and *Lima duplicata*, Sby. The outline is similar, but both species have more numerous ribs, and much too close together for our species.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

*LIMA ? BRAAMBURIENSIS* (Sby.), Phillips?, Pl. 21, fig. 12.

*Avicula braamburiensis*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 240, t. 11, f. 5.

*Obs.* Mr. Moore figured a fragment of a shell under the above name, and it is to be presumed that when using it he had in view the species so named at various times by Sowerby or Phillips. No description was given, but it appears absolutely certain that the Australian shell figured by Moore is not the species he imagined it to be.

\* Kreidebild. Texas, 1852, p. 63, t. 8, f. 7a and b.

† Verst. Nord. Ool.-Gebirges, 1836, t. 12, f. 10.

Nor is it at all certain what it may be, and I quite agree with an opinion expressed by Prof. Ralph Tate, at a late meeting of the Australian Association for the Advancement of Science,\* that it is impossible to arrive at a definite solution of this shell's identity.

*Avicula braamburiensis*, Phill., is a much more oblique species than that represented in Moore's figure, and agrees much better with our figure of *Lima Randsi* (Pl. 21, fig. 13), but the costæ of the former are finer and more numerous.

Prof. Tate suggested *Pecten* as a genus for this fragment, and it is quite possible he may be right; but as the figure appears to show some degree of obliquity I have placed it provisionally in *Lima*.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

LIMA? MULTISTRIATA, Moore, Pl. 24, fig. 17.

*Lima multistriata*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 248, t. 12, f. 5.

*Sp. Char.* Shell very convex, oblique; ears very small; hinge-border very narrow; surface with about forty depressed rounded costæ, with narrow interstitial spaces. (*Moore*.)

*Obs.* This species can only be regarded as a very unsatisfactory one from the state of preservation of the original specimen. This is stated by Mr. Moore to be "somewhat abraded," and with the ventral margin incomplete. I much question if an identification could be effected by means of the description and figure.

The name *Lima multistriata* had, according to Gümbel, been already applied by Geinitz to a species of the present genus.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

## Order—MYTILACEA.

### Family—AVICULIDÆ.

#### Genus—OXYTOMA, Meek, 1864.

(Smithsonian Check-list N. American Cret. Foss., p. 29.)

OXYTOMA ROCKWOODENSIS, *sp. nov.*, Pl. 24, fig. 15.

*Sp. Char.* Shell (left valve) subrotundate, very convex and tumid, alate posteriorly, and more or less oblique. Hinge-line straight, but not equal to the width of the shell; ventral margin obliquely rounded. Anterior ear, or wing, not well preserved, but apparently not distinctly separable from the anterior end of the shell; posterior wing moderately large, flattened, abruptly cut off from the body of the shell by a marked posterior slope. Umbo depressed but evenly convex, inrolled but not greatly overhanging the hinge-line. Surface with fourteen or fifteen strong, simple, non-spinous, distinct radiating costæ, the interspaces flattened, or even a little concave, occasionally bearing a smaller interpolated rib, but quite distinct from the larger ones, the interspaces being crossed by almost microscopic wavings; the posterior wing bears not more than one or two costæ.

*Obs.* The present species is evidently congeneric, so far as the characters of the left valve go, with those bivalves for which the late Mr. F. B. Meek proposed the genus *Oxytoma*—viz., *Avicula Münsteri*, Bronn; *A. echinata*, Münster; and *Avicula costata*, Sby. These remarks are, of course, made on the supposition that the flat valve will correspond with those of the foregoing species; at present, however, it is unknown.

*O. rockwoodensis* also stands in the same relation to Stoliczka's *Pseudomonotis semiglobosa*,† and is even closely related specifically. But the Indian shell is not a

\* Proc. Austr. Assoc. Adv. Sci. for 1888 [1889], i., p. 229.

† Pal. Indica (Cretaceous Fauna), 1871, iiii., Pts. 5-8, p. 402, t. 26, f. 1.

*Pseudomonotis*, and does not agree with the peculiar Bivalve for which Beyrich\* instituted the latter genus—viz., *Monotis speluncaria*, Schl. From Stoliczka's species, *O. rockwoodensis* differs in its much greater size, larger number of costæ, presence of the smaller interpolated ones, and an increased convexity of the surface; nor do I think that it is in any way connected with Moore's *Avicula simplex*,† *A. æqualis* (Pl. 24, fig. 3), or his *Arca* (?) *plicata* (Pl. 24, fig. 5), as our shell is much too generally globose, and possesses a different posterior wing, and on the whole, appears to agree better with the left valve of *Oxytoma* than with any other genus. Of some of these supposed species I have seen the types in the Bath Museum, and can only say that the species are founded on wretchedly small and most unsatisfactory material. *Oxytoma* is a typical *Avicula*, but more inequivalve, with a very deeply cut byssal sinus close under the anterior auricle of the right valve; the left valve, on the other hand, should be convex, or even globose, sharply ribbed, or echinated, and with a somewhat deeply cut posterior wing. *O. rockwoodensis* is no more convex about the umbonal region than the Oolitic *Oxytoma echinata*, Sby.

Loc. Rockwood Station, Landsborough River (*R. L. Jack*); Aramac (*The late James Smith*).

OXYTOMA? SIMPLEX, Moore, Pl. 24, figs. 2-5.

*Avicula simplex*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 247, t. 11, f. 3 (? f. 4).

„ *æqualis*, Moore, loc. cit., t. 11, f. 4 (? f. 3).

*Arca plicata*, Moore, loc. cit., p. 249, t. 12, f. 6.

*Sp. Char.* Shell small, very inequilateral. Left valve convex, thickened about the umbonal region; right valve flattened, plain. In the left valve the cardinal margin or hinge line straight, long. Posterior wing very extended; anterior wing small. Surface with seven or eight sharp, well-separated radiating costæ and a few concentric laminae.

*Obs.* In describing *Avicula simplex* and *A. æqualis*, Mr. Moore would appear to have transposed the numbers of the figures representing these fossils in the eleventh plate. His definition of *A. simplex* corresponds not to fig. 3, as stated, but to fig. 4, and *vice versa*; the description of *A. æqualis* is applicable to the latter figure, and not to the former. The types of these so-called species are in the Bath Museum, and have been examined by me. Both are very small shells, and the original of Moore's fig. 5 (*A. simplex* as it should be) is fairly well represented. But the type of his fig. 3 (*A. æqualis* in reality) is a very obscure specimen, and is more correctly represented in our Pl. 24, fig. 2. It is the opposite valve to Moore's fig. 4, and may quite well represent its right valve; in fact, if this is so, it will fairly well accord with what takes place in other species of *Oxytoma*.

I cannot see on what possible grounds Moore separated from the foregoing a small shell termed by him *Arca plicata*. There is no evidence of its *Arca*-affinity; but having the entire outward appearance of *O. ? simplex*, I have united it with the latter.

Loc. Wollumbilla (*The late Rev. W. B. Clarke*); Minmi, near Roma (*R. L. Jack*).

Genus—PSEUDAVICULA, gen. nov.

*Gen. Char.* Shell in general outline meleagriform, but devoid of an anterior wing or ear. Valves compressed, closed, nacreous within, bi-convex, inequilateral. Cardinal margin thin, no area, or hinge teeth, but probably with a small ligament. Posterior wing moderately developed, but with little or no emargination. Adductor muscular scars subcentral, of medium size.

\* Zeitsch. Deutschen Geol. Gesellsch., 1862, xiv., p. 10.

† Quart. Journ. Geol. Soc., 1870, xxvi., t. 11, f. 3.

*Obs.* This genus is proposed to include two shells described by Mr. Moore as referable to *Lucina*, the characters of which are but imperfectly known to me; nevertheless, they are sufficiently clear to show that they cannot be referred to a so-called Dimyarian genus, but in all probability partake more of the nature of the *Aviculidæ*. The genus must, therefore, be looked upon as, to some extent, provisional.

Although I never understood Moore's reference of his species to *Lucina*, it was not until Mr. H. Y. L. Brown forwarded a series of specimens to the Natural History Museum, London, from Coottanoonna, in South Australia, that I was able to satisfy myself that *Lucina anomala* and *L. ? australis* were not *Lucinæ*, but a Monomyarian shell.

Moore described both his species as nacreous, and this should have at once been sufficient to exclude these shells from the *Lucinidæ*. The separation into two species depended only on the presence in one of finer costæ, and a less extended anterior hinge-line. The condition of the surface costæ is perhaps due to preservation; and as regards the "less extended anterior hinge-line," the extended portion is posterior and not anterior, and the degree in this particular case is again to some extent a question of preservation. When perfect the shells are decidedly inequilateral, and this at once does away with the mesial beaks. The only remaining *Lucina* character is the lunule said to exist in *L. anomala*, but I have failed to detect such a structure in the specimens examined by me.

The point of view here advocated is supported by the nacreous character of the shell, the absence of hinge teeth, and the presence of a large adductor muscle, which is shown in one of Mr. Brown's specimens. The essential points in the genus, in addition to the general shape, are the absence of an anterior ear, the anterior margin being regularly and gently rounded; small byssal sinus; and the simplicity of the hinge mechanism. I am not acquainted with the latter as thoroughly as I could wish, but from the appearance of the cardinal margin in Pl. 24, fig. 12, the absence of teeth can safely be surmised. In all probability the valves were held together by a small external ligament and internal cartilage, placed in a groove, visible in the figure, as described by Hudleston. It is hardly necessary to point out that these shells are quite distinct from *Avicula*, as typified by *A. hirundo*, Linn.

*Type*—*Lucina anomala*, Moore.

*PSEUDAVICULA ANOMALA*, Moore, sp., Pl. 24, figs. 6, 8, 11.

*Lucina anomala*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 251, t. 14, f. 4.

*Sp. Char.* Shell suborbicular, generally compressed, thin, posteriorly alate; valves slightly convex, flattened towards the margins. Dorsal margin short, straight on the posterior side; anterior margin rounded below, abruptly cut off and obliquely rounded above; posterior margin obliquely sub-truncate, entire posterior wing flattened, the angle rounded. Umbones small but prominent; byssal sinus small, distinct. Sculpture consisting of a large number of very fine regular radiating costæ, becoming parallel to the dorsal margin on the wing, crossed by equally delicate concentric lines, broken up into broad bands or laminae, giving rise to flattened quadrangular spaces, the points of intersection becoming delicately serrate.

*Obs.* This species invariably occurs in large numbers matted and compressed, always presenting the same physical appearance, and invariably of the same size, seldom exceeding eleven-sixteenths of an inch in transverse measurement. I at one time took this and the following species to be one, but the constant uniformity in size and much sharper surface sculpture of the present shell compel me to retain them separately—at any rate, provisionally so. Moore speaks of his *Lucina ? australis* as

larger than the *L. anomala*, a remark which will bear out the identification now made, but I opine that Moore's figure of the last-named species is magnified, as I have not met with a specimen so large. *Pseudavicula anomala* is a pretty shell, and, from the quantity in which it occurs and its glistening appearance, forms an attractive specimen in any cabinet. I do not find any difference in the size of the valves, so it was probably equivalve, as Moore says.

*Loc. and Horizon.* Wollumbilla (*The late Rev. W. B. Clarke* ; *G. Sweet*—Colln. Sweet, Melbourne) ; Maranoa River, half a mile above Mitchell Railway Station (*R. L. Jack*) ; Maranoa (*G. Sweet*—Colln. Sweet, Melbourne).

*PSEUDAVICULA AUSTRALIS*, Moore, sp., Pl. 24, figs. 7, 9, 10, 12, and 13.

*Lucina? australis*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 251, t. 14, f. 5.

*Avicula orbicularis*, Hudleston, Geol. Mag., 1884, i., p. 341, t. 11, f. 10.

*Pseudavicula anomala* (pars.), Hudleston, Geol. Mag., 1890, vii. (3), p. 244.

*Sp. Char.* Shell generally meleagriniform in outline, unequally orbicular, and possessing but little convexity of valves. Dorsal margin short, straight on the posterior side, involute on the anterior side, with a byssal sinus of moderate size ; anterior margin obliquely and sharply cut off above, rounded below ; ventral margin fully rounded ; posterior margin sub-truncate, obliquely inclined upwards ; posterior wing small, rather flattened, angle rounded. Umbones slightly more anterior than posterior, small and sharp, but depressed. Adductor scar almost central, large, longitudinally elongated and bearing crescentic impressions. Surface sculpture as in the preceding species, but less sharply defined.

*Obs.* *P. australis* is decidedly larger than that I take to be *P. anomala*, and although the sculpture is of the same type, it is never, so far as my experience goes, so sharp and regular. The test of *P. australis* must have been very thin, as it is seldom actually preserved. The only hinge structure so far made out is a simple involution of the dorsal margin (Pl. 24, fig. 12) in which the ligament was placed.

The shell figured by Mr. Hudleston as *Avicula orbicularis* is without doubt identical with the present species. I am convinced of this after comparing the type at the Natural History Museum with numerous other specimens collected by Mr. H. Y. L. Brown in South Australia.

Prof. Ralph Tate would appear to refer \* Hudleston's *Avicula orbicularis* to *Maccoyella Barklyi*, Moore ; but in so doing he is clearly wrong, their structure being quite distinct.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke* ; *G. Sweet*—Colln. Sweet, Melbourne) ; Maranoa River (*G. Sweet*—Colln. Sweet, Melbourne) ; Coottanoonna, S. Australia (*H. Y. L. Brown*—Colln. Brit. Mus., London) ; Lake Eyre District (*Prof. R. Tate*—Colln. Adelaide University).

#### *Genus—MACCOYELLA, gen. nov.*

*Gen. Char.* Shell oval, or orbicular, inequivalve, inequilateral, slightly produced obliquely at times, and with a flattened, sub-truncate, or slightly emarginate posterior end in both valves. Valves plano-convex, slightly concavo-convex, or more or less bi-convex. Anterior end sometimes more or less lobate. Cardinal margin straight on the posterior, but oblique on the anterior side. Hinge much thickened and strongly grooved for cartilage attachment in both valves ; in the right or generally non-convex valve the hinge is strongly inflected or folded inwards at or anterior to the umbo, producing a deep, narrow, and obliquely directed byssal sinus ; in

\* Proc. Austr. Assoc. Adv. Sci. for 1888 [1889], i., p. 230.

the left or convex valve the hinge area is shorter, wider, and triangular under the umbo, and is divided more or less distinctly into two ill-defined cartilage concavities, separated by a rather prominent ridge; the folding of the hinge of the right valve gives to it the appearance of possessing a deeply separated and lobate small anterior ear. In the left valve the anterior ear is not defined from the body of the shell, but is represented by a corrugated thickening of the hinge. Adductor impression very large. Surface bearing radiating costæ, more numerous on the left valve, delicate concentric striæ, and concentric growth-laminæ, the points of intersection being sometimes spinose.

*Obs.* I have much pleasure in proposing this genus in honour of Professor Sir F. McCoy, of Melbourne, taking for the type species Moore's *Avicula Barklyi*.

It is hardly necessary to mention that the shells included by the late Mr. Moore in *Avicula* do not in any way correspond to that genus, as restricted by Lamarck, and typified by the well-known *Avicula hirundo*, Linn. In the Queensland shells there is an entire absence of the narrow extended posterior wing, deeply emarginate posterior end, and the small pseudo-cardinal teeth of *Avicula*; but, on the other hand, there is a much greater inequality of the valves and a peculiar hinge mechanism quite foreign to the genus quoted.

The chief peculiarities of *Maccoyella* lie in the structure of the hinges of both valves. In the right valve of the type species and *M. reflecta* there is a broad and strong area, with many longitudinal cartilage furrows, the course of which is interrupted by a strong inward inflection, or fold of its substance, having much the appearance of a small lobate ear, and in addition giving rise to a narrow but deep byssal sinus. It does not, however, appear to partake of the true nature of an auricle. The fold is well shown in Pl. 23, figs. 6 and 7, and the false ear in Pl. 22, figs. 4 and 5, and Pl. 23, fig. 2; but it will be observed that the cartilage furrows are continuous along the whole length of the area (Pl. 23, fig. 7).

In the convex or left valve the area is similar, but in addition somewhat triangular under the umbo, and there would appear to be two depressions in which thickened portions of the cartilage, or plugs, were inserted.

The umbo in the left valve is prominent, convex, and overhangs the hinge to some extent, but it is not usually inrolled. In the right valve it is insignificant. The muscular impressions are only known in the type, and will be found described under that species.

*Avicula Barklyi*, Moore, approaches more closely to *Meleagrina*, Lamk., especially in the convexity of its valves, broad cartilage area, form of the posterior wing, deep byssal sinus, and the small cleft pseudo-ear of the left valve. On the other hand, the size of the right umbo is quite unlike that of *Avicula margaritifera*, Linn., the Mother-of-Pearl Oyster, and type of the genus *Meleagrina*, not to mention the inflection of the cartilage area. The tumidity and prominence of the right umbo would appear to indicate a relation to *Oxytoma*, Meek, typified by *Avicula Münsteri*, Bronn, but the posterior wing and byssal notch differ so widely from those of Moore's species that they can hardly be congeneric.

I am sorry to be unable to agree with so distinguished an authority as Prof. R. Tate in referring the shell now under discussion to the genus *Monotis*, Bronn. The latter, as represented by *M. salinaria*, Bronn,\* is an ovate compressed shell, almost equivalve, with the beaks only slightly projecting, and in no way whatever resembling Moore's species. The same remarks apply to other allied genera, such as *Halobia*, Bronn, and *Daonella*, Mojsisovics. None of the genera previously mentioned possess

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\* Jahrb. für. Min., 1830, p. 284, t. 4, f. 1.



the peculiar hinge structure of *Avicula Barklyi*, so far as I have been able to ascertain. There is a resemblance, however, with *Pseudomonotis*, Beyrich,\* in the proportion of the valves, deeply cleft pseudo-ear, and strong byssal sinus; but in the type, *P. speluncaria*, there is no posterior wing, but an irregular auriculate end, without any parallel in the Queensland shells. Especially does *Maccoyella* approach those shells from the Carboniferous Series of the Salt Range, in India, described by Dr. A. Waagen,† such as *Pseudomonotis garforthensis*, King,‡ or *P. kazanensis*. Even Waagen's species differ a good deal from *P. speluncaria*, and I much question if they can be regarded as true members of the genus *Pseudomonotis*. We are unable to discover from Waagen's remarks that the hinge structure of his shells and *Avicula Barklyi*, Moore, in any way agree in detail. His description of *P. kazanensis* is as follows:—"The hinge is very simple. It shows in the middle a somewhat triangular emargination, very likely for the reception of a cartilage. Anteriorly to it there is a broad facet, which reaches to the end of the anterior wing. Its lower margin is somewhat prominent, and forms a kind of very indistinct elongated tooth. Posteriorly to the ligamental groove the hinge-line is simply thickened."

The nearest ally of *Maccoyella*, so far as my researches have yet gone, is undoubtedly Whitfield's *Meleagrinnella*,§ typified by *Avicula curta*, Hall.|| The resemblance lies in the general appearance of the two genera, the presence of a deeply cut-off ear in the right valve, and the thickened area of the left valve. But the structure of the divided ear and hinge-line of the right valve is wholly different, as the following quotation will show. Speaking of the byssal fold, Whitfield says it is "either a deep channel on the external surface of the shell extending from the margin to near the beak of the valve, or a simple deep straight notch separating the wing into a linear process, of greater or less length, from the body of the shell." There is no structure here corresponding to the inflection or fold of the hinge in the right valve of *Maccoyella*, nearly central in position, whereas the byssal fold of *Meleagrinnella* is anterior. In addition to this, the inequality in the size of the shell in the two genera is most marked. Under these circumstances I believe I am justified in separating Moore's shells as the types of an undescribed genus.

The whole group of species, but more especially the type, *M. Barklyi*, bear in their external appearance a marked resemblance to some inequilateral forms of *Hinnites*, such, for instance, as *H. Studeri*, Pictet and Roux, from the Gault of St. Croix.¶

The number of species referable to *Maccoyella* is at present open to doubt. Moore described the following under the name of *Avicula*:—*Avicula Barklyi*, *A. reflecta*, *A. umbonalis*, *A. corbiensis*, *A. substriata*, *A. simplex*, and *A. æqualis*, but the two last may be at once dismissed from consideration. The late Rev. J. E. T. Woods\*\* clearly considered the whole as varieties of one species. He wrote: "Anyone who examines the series figured by Mr. Moore from Wollumbilla, including eight species, will be inclined to refer them all to one, differing from each other merely in size and mode of growth." With all due respect to this adverse opinion, it is not so easy to refer all of

\* Zeitsch. deutschen Geol. Gesellsch., 1862, xiv., p. 10.

† Pal. Indica (Salt Range Fossils), Vol. i., 1881, Pt. 3, p. 276.

‡ Loc. cit., t. 22, f. 2.

§ Mon. U.S. Geol. Survey (Powell's), 1885, ix. (Raritan Clays and Greensand Marls of New Jersey), p. 71.

|| U. S. Geogr. Geol. Survey (Powell's) Rocky Mountain Region (Pal. Black Hills of Dakota), t. 3, f. 20-25.

¶ Pal. Suisse, 5me. Série, 4me. Pt., p. 232, t. 179, f. 1.

\*\* Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 2, p. 240.

the before-mentioned shells to one species, and rash statements of the kind quoted do not tend to assist in unravelling the question. I have retained *Maccoyella Barklyi*, *M. reflecta*, *M. umbonalis*, *M. corbiensis*, and *M. ? substriata*.

It is even possible that an additional species may exist. Pl. 24, fig. 1, represents a right valve\* devoid of the posterior wing, without costæ, but possessing strong concentric laminæ and the general peculiar shape and shell-structure of a *Maccoyella*. It seems distinct from either of the other species placed in this genus.

The hinge structure of the various species of *Maccoyella*, although appearing to differ widely at first, is found on examination to follow a well-marked plan, and afford a really excellent example of palæontological morphology, from the semi-pectinoid outline and restricted and convoluted hinge of *M. Barklyi* and *M. reflecta* to the gryphæa-form shape, and small area of *M. corbiensis*. Between these two extremes stands *M. umbonalis*, acting as a connecting link. In *M. Barklyi* and *M. reflecta* the umbonal fold is thick and projecting, but short, the byssal fold on the contrary being much longer and projecting inwards, with a very deep and narrow byssal sinus anterior to it. The hinge is thus much broken up, and does not present the same regularity of outline as seen in *M. umbonalis* and *M. corbiensis*. In the right valve of the first of these species, being that with which I am best acquainted, the dorsal margin is long and obliquely bevelled, the area comparatively flat with a decided submedian cartilage depression, and the folds, umbonal and byssal, prominent, but not nearly to the same extent as in the two former species. The umbonal is nearly vertical, with the larger portion of the concave cartilage depression posterior to it. The byssal fold is less prominent still, wherein this species departs greatly from the typical structure of *M. Barklyi* and *M. reflecta*, and the byssal sinus is tolerably long but not very deep. In *M. corbiensis* the hinge structure least resembles that of the genus of any of its species. The dorsal margin of the left valve is much arched, widening out below the umbo into a rather triangular, concave, cartilage area, divided excentrically by the umbonal fold, the byssal fold being obsolete.

The hinge structure of the smaller species referred to *Maccoyella* is unknown to me.

The structure of the test in *Maccoyella* is non-prismatic, and apparently laminar-fibrous. Thin sections show no trace of the prismatic-cellular structure of the *Aviculidæ*; but as I cannot be certain that the actual outer layer has been examined, a decision on this point must be suspended. It is probable that the interior of the valves was nacreous. The surface of the best-preserved examples examined by me shows a hackly-laminar appearance irrespective of the outside ornament.

The distribution of *Maccoyella* is very extensive. The original localities recorded by Moore are Wollumbilla and Mount Corby (Rolling Downs). Species have since been obtained by the Hon. A. C. Gregory at the Walsh River (Rolling Downs); by Messrs. Jack and Rands at Maryborough (Desert Sandstone); probably also by the latter at the Isis River (Desert Sandstone); by Messrs. Jack and Samwell at the Croydon Gold Field (Desert Sandstone); and probably by Mr. Jack at Minmi, near Roma (Rolling Downs). Numerous examples have been collected by Mr. H. Y. L. Brown in the Lake Eyre District, South Australia; whilst Prof. R. Tate has recorded the presence of the genus in the Peak District of the same Province. Finally, as intermediate between the Queensland and South Australian localities, the late Rev. J. E. T. Woods has figured examples from the Gray Ranges, on the borders of this and the former Colony.

*Type*—*Avicula Barklyi*, Moore.

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\* It was collected by my Colleague at Richmond Downs, Flinders River, from the Rolling Downs Formation.

## MACCOYELLA BARKLYI, Moore, sp.

Pl. 22, figs. 1-5; Pl. 42, figs. 4-6; ? Pl. 23, figs. 1 and 2.

*Avicula Barklyi*, Moore, Quart. Journ. Geol. Soc., 1870, xxviii., p. 245, t. 11, f. 1-2.*Streptorhynchus Davidsoni*, Etheridge, *Ibid.*, 1872, xxviii., p. 333, t. 17, f. 1.*Monotis Barklyi*, Tate, Trans. R. Soc. S. Australia, 1885, vii., p. 76.

*Sp. Char.* Shell sub-orbicular, sometimes irregularly or slightly obliquely so; test thick; valves plano-convex, or slightly bi-convex; hinge hardly as long as the shell; ventral margin rounded. Posterior wing more or less flattened in the right valve, and much larger than in the left, where it is sharply cut off by an umbonal ridge; posterior margin usually rounded and graduating into the ventral. Umbones very unequal; in the right valve small and inconspicuous; in the left prominent and blunt, projecting above the dorsal margin, but not greatly overhanging it. Scar of the adductor large in the right valve, nearly central, sub-reniform in outline; a deep pit is present behind the inflected portion of the cartilage area, and united to the adductor scar by a series of muscular pits arranged in a semicircle. The radiating costæ of the left valve are strong and prominent, from nine to thirteen in number, but fewer than those of the left; the posterior costa, and sometimes others, stronger and larger than the others, and bearing strong projecting spines; intercostal spaces with a secondary costa between every pair of primary costæ; the right valve bears a largely increased number of costæ; in both valves are several broad concentric laminæ of growth, but in the right these become elevated on the anterior dorsal margin into prominent undulating ridge-like folds.

*Obs.* Mr. Moore stated that sections of this shell were to be found in almost every block of matrix from Wollumbilla examined by him, a fact I am able to confirm from independent observation. It is also true that *M. Barklyi* possesses a much wider geographical range than was at first contemplated by its describer. Furthermore, it is one of the most important shells, from a stratigraphical point of view, met with in the Upper Mesozoic Rocks of Eastern Australia.

The surface costæ in *M. Barklyi*, although varying in individuals to some extent, are characteristic, but this variability may perhaps have some relation to the state of preservation of the specimens. The left valve bears from nine to twelve\* or even thirteen sharp, separate, and prominent ribs, usually alternating with an equal number of finer secondary ribs which stop short of the umbo by some little distance. The posterior wing is free of costæ and separated from the body of the valve by the most posterior principal costa, which takes the place of an umbonal or diagonal ridge in the higher bivalves. The secondary costæ are sometimes increased to two, or even three, between each pair of primary, but the latter number is rare. The whole valve is concentrically crossed by well-marked laminar imbrications, the points of intersection with the primary costæ projecting as spines (Pl. 22, fig. 3; Pl. 42, figs. 4 and 5), especially in young individuals; but in more mature individuals these projections become worn down, and are retained in some cases only on the last posterior, the penultimate, and the anti-penultimate costæ. The presence of these spines gives to the fossils much the appearance of the genus *Plagiostoma*. One peculiar fact in connection with the concentric laminæ is the manner in which they pass over the anterior dorsal margin as ridge-like folds (Pl. 22, fig. 2; Pl. 23, fig. 4), and there is reason to believe they are conterminous with some of the cartilage furrows of the anterior area.

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\* In one case only six were observed.

The right valve is invariably but slightly convex, so far as my own observation has gone, and the umbo insignificant. The valve is, however, traversed by a much larger number of costæ of both orders, but there is no appearance of the ridges on the anterior dorsal margin. Both valves have the intercostal spaces concentrically traversed by very fine delicate wavy lines (Pl. 22, figs. 1-3); indeed, this appears to be a character common to the whole group (Pl. 23, figs. 1-3). The right valve at times assumes a transversely elongated outline, giving to it a most unusually inequilateral appearance. This seems to be caused by a prolongation or extension of the depressed anterior end (Pl. 22, fig. 4), and is particularly noticeable in specimens from the Croydon Gold Field.

The large adductor impression in the right valve is nearly central, and is connected by a line of muscular points of attachment to a deep and pit-like excavation under the inflection of the area. This, in casts, appears as a sharp projecting point. On the anterior side of the adductor the muscular attachments become clustered, and are placed at some considerable distance from the anterior margin.

The resemblance of *Maccoyella Barklyi* to *Pseudomonotis garforthensis*, King, has been already dwelt on. With *M. umbonalis*, Moore, and *M. corbiensis* of the same author, we are at present not thoroughly acquainted, but it would appear that the very central position of the umbones in the former, the increased convexity in the latter, and the more numerous and regular radiating costæ in both may be taken as points for future separation—that is, supposing these shells to be separate and valid species.

Through the kindness of Mr. C. W. De Vis, I have been able to examine the shell named *Streptorynchus Davidsoni*,\* by Mr. R. Etheridge, F.R.S., which formed a portion of Mr. Daintree's Collection. I find it to be an undoubted *Maccoyella*, either *M. reflecta*, or this species, probably the latter, and is either from Wollumbilla, or the Walsh River, it being rather difficult at times to distinguish the matrices apart.

A rather worn specimen (Pl. 23, figs. 1 and 2), is provisionally united with *M. Barklyi*, as it appears to accord better with that species than with *M. reflecta*. The shell, measuring nearly two and a-half inches square, is larger than the generality of individuals of the former. It is from the Walsh River.

In Pl. 22, fig. 3, I have given an illustration of the Maryborough variety of *M. Barklyi*, which is distinguished by the size and rugosity of the primary costæ and the development of the posterior spines; and it is, in addition, a smaller shell. In an internal cast from this locality the costæ also appear to terminate along the front margin in a series of free spines. Similar features are present in the form of our shell from Croydon (Pl. 42, fig. 5).

Loc. Wollumbilla (*The late Rev. W. B. Clarke*); Walsh River (*Hon. A. C. Gregory*); Bungeworgorai Creek, near Mount Abundance; Blythesdale Station, between Wollumbilla and Roma; Maranoa River, at Mitchell† (*G. Sweet*—Colln. Sweet, Melbourne). In South Australia at Peak Creek (*Messrs. J. S. Chandler and J. Canham*‡); and forty-five miles south-west of Cootanooonna, Lake Eyre (*H. Y. L. Brown*—Colln. Nat. Hist. Mus., London). Occurs also in the Desert Sandstone.

\* Quart. Journ. Geol. Soc., 1872, xlviii., p. 333, t. 17, f. 1.

† With the valves in apposition, and the best examples I have seen.

‡ *Teste Tate*, Trans. R. Soc. S. Australia for 1879-80 [1880], iii., p. 179; *Ibid.*, 1880-81 [1882], iv., p. 149.

## MACCOYELLA REFLECTA, Moore, sp.

Pl. 20, figs. 1, 3, 5, 7, and 10.

*Avicula reflecta*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 246, t. 12, f. 1.,, *Barklyi*, var. *reflecta*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 2, p. 240, t. 12, 4-6.

*Sp. Char.* Shell large, transversely oval; valves to some extent compressed, especially on the posterior side, very inequivalve, inequilateral, plano-convex, or concavo-convex. Right valve either flat, a little concave, or slightly convex in the umbonal region, becoming concave and then flat towards the ventral margin; anterior dorsal margin moderately obliquely inclined; posterior dorsal margin straight; area inwardly bevelled, wide, with a thickened inflection, strong cartilage furrows, and a narrow, deep, and inwardly curved byssal sinus; umbo small and nucleus-like, posterior wing large and flattened, margin roundly truncated. Left valve convex, but not strongly so, the greatest convexity being in the umbonal region, thence rapidly decreasing to the ventral margin; umbo elevated, but not highly so, or gibbous; anterior folds of the area not particularly coarse; posterior wing not sharply marked-off from the body of the shell flattened. Surface of the right valve bearing a very large number of radiating ribs or costæ of nearly equal size, covering the whole valve. Left valve similarly ornamented, but the costæ stronger, present on the posterior wing, and every fourth rib larger than the others. Concentric laminæ of both valves widely separated; points of intersection of the laminæ and costæ elevated into projecting frills. Muscular impressions as in the type species.

*Obs.* The shells that I have considered referable to Moore's *Avicula reflecta* are of much larger size than the preceding, *Maccoyella Barklyi*, and in comparison it must be borne in mind that Moore's figure was reduced one-half. In addition, the whole shell is much less convex, the right valve flat, or, what is more usually the case, convex in the umbonal region, becoming concave forwards. The surface costæ are much more numerous, and in the right valve smaller, giving to that valve a far more finely striated appearance than the corresponding half of *M. Barklyi*. There is little short of forty or fifty costæ on the left valve of *M. reflecta*, and in extreme specimens perhaps even more, but, as in the case of the former species, the number of secondary costæ between the primary varies to some extent. The principal costæ do not appear to project at the points of intersection of the concentric laminæ, as semi-tubular spines, so far as I have been able to ascertain. The convexity of the left valve in this species is fairly marked in the dorsal portion of the valve; yet, at a point about midway between the dorsal and ventral margins, the diameter of the valves, when in apposition, as ascertained from two fractured examples, is only seven-eighths of an inch.

The inflection of the area of the right valve is very marked in this species, the inturned portion forming a kind of plug, filling the excavated portion of the left area immediately under the umbo of that valve.

The muscular impressions appear similar to those of *M. Barklyi*, but are not as deeply excavated.

The geographical distribution is equally wide with that of *M. Barklyi*. Irrespective of the Queensland localities, Mr. H. Y. L. Brown has obtained it at Primrose Springs, north of Lake Eyre; specimens are in the Mining and Geological Museum from Milparinka, and Dunlop Station, Darling River.

*Loc. and Horizon.* Wollumbilla (*The late Rev. W. B. Clarke*); Bungeworgorai Creek, near Mount Abundance (*G. Sweet*—Colln. Sweet, Melbourne); Lake Eyre Basin (*H. Y. L. Brown, and Prof. R. Tate*). Occurs also in the Maryborough Beds—Desert Sandstone.

*MACCOYELLA UMBONALIS*, Moore, sp., Pl. 22, figs. 6-7, Pl. 23, fig. 4.

*Avicula umbonalis*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 246, t. 12, f. 2 and 3.

*Sp. Char.* Shell large, transversely ovate, almost plano-convex, nearly equilateral; dorsal margin long, straight, nearly equal on both sides the umbones. Left valve moderately convex, its umbo much produced, and incurved over the hinge-line; anterior, posterior, and ventral margins rounded, the first slightly obliquely so, especially above, leaving a well-marked byssal sinus; anterior dorsal margin much crenulated, as in *M. Barklyi*. Right valve more or less flattened, or slightly convex. Hinge area of the left valve moderately large, intersected by the two transverse folds, one immediately posterior to the byssal sinus, the other below the umbo, leaving posterior to it the greater portion of a shallow triangular depression; that of the right valve is similar, with folds corresponding to the depressions of the former. Adductor impression very large. Surface with a very large number of close radiating costæ, crossed by equally numerous concentric laminæ, the costæ on the right valve becoming almost subordinate to the laminæ.

*Obs.* I have not seen anything approaching a perfect specimen of the left or convex valve of this species, although an impression and an excellent right valve exists in Mr. Sweet's Collection. It is the largest *Maccoyella*—a mutilated left valve obtained by Prof. Tate at Lake Eyre, in South Australia, measuring four inches from anterior to posterior, and four and a-half inches from the dorsal to the ventral margin. Mr. Sweet's right valve is six inches in transverse measurement, and five and a-half inches in the contrary direction. I think there is little doubt also that our Pl. 23, fig. 4, is this species, and represents an exfoliated right valve, with the umbo and crenulations of the left anterior dorsal margin perceptible above it. The impression of the left valve referred to above measures five inches in both directions. The radiating costæ are very numerous, and appear to extend beyond the ventral margin as spinous prolongations, similar to *M. Barklyi*, var. *mariaeburiensis* (Pl. 42, fig. 4). The costæ are crossed by moderately wide growth-laminæ, which, at the points of intersection, project as half-spines or frills.

The structure of the hinge in *M. umbonalis* is remarkably interesting, differing in some degree from that of *M. reflecta*, and paving the way for the structure of that of *M. corbiensis*.

The large shell from Maryborough (Pl. 23, fig. 4), apparently either much decorticated, or split in half, with the shelly layers remaining along the hinge-line, measures five inches by four and a-quarter, and there are still remaining indistinct traces of the radiating costæ. An imperfect specimen in the Mining and Geological Museum measures six inches transversely from side to side, and four from the left umbo to the imperfect front or ventral edge. Another, still less perfect, from the Australian Museum Collection, is four and a-half inches by four. These measurements will show that *M. reflecta* attained a large size.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*); Bungeworgorai Creek, near Mount Abundance (*G. Sweet*—Colln. Sweet, Melbourne). Occurs also in the Maryborough Beds—Desert Sandstone.

*MACCOYELLA CORBIENSIS*, Moore, sp., Pl. 22, figs. 8 and 9.

*Avicula corbiensis*, Moore, Quart. Journ. Geol. Soc., 1870, xxxi., p. 246, t. 11, f. 7.

*Crenatula* ? *gibbosa*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 339, t. 19, f. 3.

*Sp. Char.* Shell longitudinally ovate, longer than wide, somewhat deltoid, nearly equilateral. Left valve very convex, longitudinally curved, area about one-third the width of the shell, much arched, with numerous fine ligamental

furrows; umbonal fold very excentric and oblique; byssal fold obsolete; byssal sinus probably narrow and long; anterior end rounded, with the foldings of its dorsal margin numerous but not strongly marked; no wing, or ear; posterior end rather produced ventrally, semi-truncate, with a short incomplete wing (when perfect); ventral margin broadly rounded; umbo elevated, deep, much incurved, and acute, its cavity hollow; adductor impression very excentric, concentrically ridged; pallial impression marked by a series of vertically impressed fibre scars; surface with a large number of radiating and bifurcating costæ; the intercostal spaces, or valleys, crossed by fine concentric lines of growth, convex in the direction of the dorsal margin.

*Obs.* By a series of specimens with the shell preserved, and another of internal casts in the Collections of Messrs. T. W. E. David and G. Sweet, I have satisfied myself that the peculiar cast described by Mr. R. Etheridge, F.R.S., as *Crenatula? gibbosa* is that of the left valve of this species. Imperfect examples only are now figured (Pl. 22, figs. 8 and 9), but in a supplementary work on Queensland Palæontology, a complete set of illustrations will be given. The right valve is not known with certainty.

In the outward form of the left valve this species resembles a *Gryphæa*, especially in the overhanging sharp umbo. It also presents some features like those of *Hinnites*, and some Oysters with hollow umbonal cavities. The peculiarities of the hinge structure are best seen in the internal casts, such as figured by Mr. Etheridge, under the name of *Crenatula? gibbosa*, and in which the infilling of the hollow umbonal cavity is always well displayed. In fact, the short, almost triangular area seems to form a kind of shelf across the cavity of the valve similar to that in some proboscidiform rostrate oysters.

The dorsal margin of this species is in the left valve much arched, widening out below the umbo into a more or less concave somewhat triangular cartilage area, excentrically divided by the umbonal fold as an oblique prominent ridge, the anterior half of the area being thus much the smaller. The byssal fold is practically obsolete, and the anterior crenulations of the dorsal margin but little developed. In casts the triangular outline of the area is more pronounced, and the umbonal fold is represented by an oblique groove.

To some extent the typical *Maccoyella* hinge structure is not at first apparent in this shell, but its generic affinity becomes apparent when viewed in connection with that of *M. umbonalis*.

The adductor impression is always large, and well to the posterior side.

It is possible that the impression of a very convex valve (Pl. 22, fig. 9) from Maryborough may be referable here. It possesses eighteen chief ribs, with smaller intermediate ones, straight, regular, and apparently non-spinous. The concentric laminæ are strongly marked, and the finer and more delicate parallel wrinklins equally apparent.

*Loc.* Mount Corby (*The late Rev. W. B. Clarke*); Bungeworgorai Creek, near Mount Abundance (*G. Sweet*—Colln. Sweet, Melbourne); Blythe's Creek, near Blythesdale Station (*G. Sweet*—Colln. Sweet, Melbourne); Lake Eyre, South Australia (*Prof. R. Tate*—Colln. Adelaide University).

*MACCOYELLA? SUBSTRIATA*, *Moore*, sp., Pl. 22, fig. 10, ? Pl. 23, figs. 8 and 9.

*Avicula substriata*, *Moore*, Quart. Journ. Geol. Soc., 1870, xxvi., p. 247, t. 11, f. 6.

*Sp. Char.* Shell of medium size. Left valve very convex or subangular in the middle line longitudinally; posteriorly very alate and extended; dorsal margin, or hinge-line, very long on the posterior side, but on the anterior oblique from the umbo forwards, and much thickened, folded, and crumpled, forming a wide byssal sinus; posterior end very wide, alate, and extended; umbo prominent, and probably

incurved; anterior and ventral margins rounded; surface bearing radiating costæ, which become stronger on the posterior wing, each pair separated by a smaller interpolated rib, the whole crossed by wavy, delicate, laminar frills, least conspicuous on the posterior wing.

*Obs.* The present shell is believed to be Moore's species (although he describes it as small) from the great expansion of the posterior wing, the absence of an anterior one, and the general resemblance to his figure. If not Moore's species, it must be an undescribed form. The folded and crumpled anterior dorsal margin is a typical feature of a *Maccoyella*, and we thus have a very interesting morphological change from the shorter posterior wing of *M. Barklyi* to the lengthened condition of that portion of the shell in the present species. The subangular convexity of the umbonal region is also a marked feature; and should this form prove distinct from *M. substriata*, Moore, it may be called *M. subangularis*. The above characters have been chiefly derived from a specimen in Mr. Sweet's Collection.

*Loc.* Bungeworgorai Creek, near Mount Abundance (*G. Sweet*—Colln. Sweet, Melbourne); Wollumbilla (*The late Rev. W. B. Clarke*).

*Genus*—*AUCELLA*, *Keyserling*, 1846.

(*Reise in das Petschora-Land*, p. 297.)

*Gen. Char.* "Obliquely elongated, inequivalve, of thin structure, pearly within, and with concentric sulcations externally; left valve strongly convex, with incurved beaks, a short posterior and an almost obsolete anterior ear, represented by a slight internal thickening; margin of shell in front below the beak insinuated; right valve flat or slightly convex near the umbo, with a small indistinct posterior and a still shorter anterior ear, generally a little twisted, and separated from the margin below by a deep byssal sinus; hinge-line in both valves straight, short, and in the right valve usually with a small blunt tooth, ligament external, linear; muscular scars small, posterior, submarginal, anterior placed near the ear, and often almost obsolete." (*Stoliczka*.) \*

*Obs.* Dr. Stoliczka's description of this interesting genus is quoted, as being the best and most comprehensive with which I am acquainted; it is to all intents and purposes the same as the original by Von Keyserling.

By most authors *Aucella* is said to be a Jurassic genus, but Eichwald believes the rocks from which the original examples were procured by Keyserling to be of Cretaceous age. Species definitely known to be of this period have been described by Stoliczka, Gabb, Conrad, and others, and there now appears to be no doubt of its existence during the epoch in question.

*AUCELLA HUGHENDENENSIS*, *Etheridge*, sp., Pl. 25, figs. 1-6.

*Avicula hughendenensis*, *Etheridge*, Quart. Journ. Geol. Soc., 1872, xxviii., Pt. 3, p. 346, t. 25, f. 3.

*Aucella Liversidgei*, *Etheridge* fil., Journ. R. Soc. N. S. Wales, for 1883 [1884], xvii., p. 90, 2nd plate (top and lower right-hand figs.)

*Sp. Char.* Obliquely sub-deltoid, very inequivalve, plano-convex. Left valve convex, inoceramiform, gibbous, and narrowed about the umbo, expanding ventrally; beak or umbo prominent and much incurved anteriorly, greatly overhanging the hinge-line; anterior side vertical, the margin almost straight, and when seen from the inside deeply insinuated under the beak; posterior side steep, obliquely expanding; posterior ear and hinge margin very short; ventral margin obliquely rounded; surface with faint concentric undulations, which become more apparent and laminar towards the ventral margin. Right valve gently convex or prominent about the umbonal region, flattened

\* *Pal. Indica* (Cret. Fauna), 1871, iii., fasc. 5-8, p. 390.



towards the ventral portion, obliquely rounded, with a larger and better developed posterior ear than in the left valve; anterior margin rounded; anterior ear more or less triangular, reposing completely in the insinuation of the anterior margin of the left valve, separated from the body of its own valve by a deep byssal sinus; beak small, but sharp and prominent. Hinge-line of both valves short, but longest in the right; no tooth visible in the interior of the right valve. Both valves are crossed by fine radiating striæ which give rise to a minute cancellation; in the left valve the striæ are more apparent below the beak, and die out on the body of the shell; in the right valve they are of a fluctuating or wavy character, and the concentric laminæ become frill-like; surface highly polished.

*Aucella hughendenensis* is undoubtedly allied to two types of the genus, *A. Pallasii*, Keyserling,\* and *A. crassicollis*, Keys.† In possessing the obliquity and short hinge-line, it resembles the former; the left valve has the general form of the latter species and a similar much incurved beak, whilst the right valve in all its peculiarities is almost identical with that of *A. Pallasii*. The resemblance of our shell to and its intermediate position between the two species in question is very remarkable. *A. hughendenensis* is also allied to the Indian Cretaceous species *A. parva*, Stoliczka,‡ but the left valve in the former is more inoceramiform than in the latter, and more oblique.

In *A. speluncaria*, Schlotheim,§ there are radiating striæ, but our species is less deltoid and more regular, and there is no inflection of the ventral margin.

*A. Hausmanni*, Goldfuss,|| from the Zechstein of Scharzfeld, is a much more slender shell than the Australian species, less convex, and more elongate from the beaks to the ventral margin. Another species, *A. caucasica*, Abich,¶ possesses fine radiating striæ, to say nothing of the larger ear in the right valve, a more pointed and prominent umbo in the left, and a generally different outline to the valves. There appears to be at least one very interesting British example of *Aucella*, the *A. gryphæoides*, J. de C. Sowerby, sp.,\*\* but it has a much larger umbo in the left valve, and the general characters of the right are quite different.

The last species with which I am able to compare *A. hughendenensis* is the American Cretaceous form of *A. Piochii*, Gabb,†† a very gibbous and thick shell through the valves, quite distinct from the Australian. It is not related to *A. plicata*, Zittel,‡‡ which differs in form, and has coarse concentric corrugations over the valves.

*Aucella hughendenensis* was no doubt a very abundant species, and probably gregarious, "masses of them occurring together, forming a compact and dense argillaceous limestone."§§ It was equally variable, for in some the radiating striæ only predominate; in others a reticulation caused by the presence of transverse concentric lines is the main feature. Two or three of the radiating ribs sometimes become very much larger and prominent. The smaller valve has at times an almost *Anomia*-like appearance, sometimes a little gnarled, and corrugated by three or four concentric ridges and corresponding depressions. In individuals of more advanced age the

\* Reise in das Petschora-Land, p. 299, t. 16, f. 1-7.

† *Ibid.*, p. 300, t. 16, f. 9 and 12.

‡ Pal. Indica (Cret. Fauna), 1871, iii., fas. 5-8, p. 404, t. 33, f. 2 and 3.

§ See Geinitz, Dyas, t. 14, f. 5-6.

|| *Mytilus*, Petrefacta Germaniæ, ii., p. 168, t. 138, f. 4; *Aucella*, Geinitz, Dyas, p. 72, t. 14, f. 85.

¶ Zeitsch. deutschen Geol. Gesellsch., 1851, iii., p. 31, t. 2, f. 1.

\*\* Trans. Geol. Soc., iv., t. ii., f. 3.

†† Pal. California, ii., t. 32, f. 92.

‡‡ Reise Oesterr. Fregatte "Novarra," 1857-59, Geol. Theil, Band I., 2 Abth., 1865, p. 32, t. 8, f. 4a-c.

§§ Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 346.

radiating striæ became almost ribs, and the concentric lines nearly died out. Locality appears to have had an influence on the size of the shell; thus, those at Aramac are rather small, those at the Barcoo larger.

The inner layers of shell have a silky lustre, with very fine anastomosing, concentric lines. A very thin and delicate shell occurs at Blackall Well, which has all the surface characters of this species, except that the concentric lines are finer or more prominent. It may, perhaps, be a distinct species.

*Loc.* Hughenden Station, Flinders River (*The late R. Daintree; The Hon. A. C. Gregory*); Rockwood Station, Landsborough River, in a light-drab shelly limestone (*Prof. A. Liversidge*—Colln. Sydney University; *R. L. Jack*); Flinders River, seven miles above Marathon Station, in a dark-drab limestone (*R. L. Jack*); Marathon (*G. Sweet*—Colln. Sweet, Melbourne); Neelia Creek, at crossing of the Cloncurry Road, in a light-drab limestone (*R. L. Jack*); Aramac Well, at a depth of two hundred and forty-four feet (*S. Sharwood*); Coorena Woolshed, twenty-four miles south of Aramac (*R. L. Jack*); Stone Hat, Rockwood Creek, Landsborough River, in a drab shelly limestone; Landsborough River, five and a-half miles north-north-west of Rockwood Station, in a yellow-drab arenaceous limestone; Jirking Creek, near its head, in a greenish limestone; Leichhardt River, seven miles from mouth of Gunpowder Creek, in a dense cream-coloured limestone (*R. L. Jack*); Warrianna Bore, at three hundred and fifty-one feet (*J. B. Henderson*); Barcoo River, right bank, six miles above Northampton Downs Station (*R. L. Jack*).

*Genus—PERNA, Bruguière, 1789.*

(*Tab. Encyclop. Method., Pl. 175.*)

*PERNA GIGANTEA, Moore.*

*Perna gigantea*, Moore, *Quart. Journ. Geol. Soc.*, 1870, xxvi., p. 249.

*Sp. Char.* Shell very large, measuring six and a quarter inches broad by five and a half inches in length, flattened; umbones depressed and rather produced; anterior byssal area rounded; hinge-line rather oblique, extending one-third the width of the shell; posterior end oblique, rounded, and folding towards the ventral margin, which, with the anterior end, is rounded. (*Moore.*)

*Obs.* *P. gigantea* was associated with *Lingula ovalis*, and a *Mytilus*, both species characteristic of the Wollumbilla blocks. The shell has not been figured, nor has it occurred to me in any of the Collections examined.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

*Genus—INOCERAMUS (J. Sowerby, 1814, m.s.), Parkinson, 1819.*

(*Trans. Geol. Soc., v., p. 55.*)

*Obs.* The genus *Inoceramus* was proposed and described in a Paper read before the Linnean Society of London on 1st November, 1814, by the late Mr. James Sowerby, entitled "On a Fossil Shell of Fibrous Structure," &c. The description was published in December, 1822;\* but, in the meantime, between the dates of reading and publication of Sowerby's paper, Parkinson published a description—viz., in 1819†—which must, therefore, be accepted as the real date of the publication of *Inoceramus*, and not 1814, as is usually given in works.

\* *Trans. Linn. Soc., xiii., Pt. 2.*

† *Trans. Geol. Soc., v., p. 55.*

The Queensland *Inocerami* appear to indicate an horizon near that of the Lower Chalk, although in a collection of fossils forwarded to England by Mr. W. Hann, from the Barcoo River, fifty miles below its junction with the Alice River, Mr. R. Etheridge, F.R.S., recognised species having the general *facies* of British Gault forms.\*

The great variability of the shells forming the genus *Inoceramus* renders it very difficult to decide on the specific identity of its individuals, and the succeeding determinations can only be accepted as provisional. As regards the Australian species, this is increased by the fact that in the majority of cases the specimens are either too ill-preserved, or too fragmentary, to yield satisfactory results. Specimens of a drab-coloured limestone have been collected by my Colleague on the Flinders River, seven miles above Marathon Station, and a calcareous flaggy bed the same distance below the Station, entirely composed of the remains of *Inocerami*. On the Cloncurry Road, in localities eight and fifteen miles west of Williams River, a white porous rock is completely built up of the disintegrated shelly matter of this genus; whilst at the second of the localities just mentioned specimens of an argillaceous limestone have been obtained, with the weathered surfaces covered with white spicular or needle-shaped bodies, which are nothing more than the broken-up prisms of the prismatic shell-structure of *Inoceramus*. These instances will serve to show the relatively great abundance of *Inoceramus* in the North Queensland Cretaceous Series.

**INOCERAMUS CARSONI, McCoy, Pl. 25, figs. 9 and 10.**

*Inoceramus Carsoni*, McCoy, Ann. and Mag. Nat. Hist., 1865, xvi., p. 334; *Ibid.*, 1867, xx., p. 196.

" " McCoy, Trans. R. Soc. Vict., 1866, vii., p. 50.

" allied to *I. problematicus* (D'Orb.), Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 344, t. 22, f. 4.

*Obs.* Both Prof. Sir F. McCoy and Mr. R. Etheridge, F.R.S., call attention to the resemblance of their respective shells to *Inoceramus mytiloides*, Sby.; and the characters mentioned by the former appear hardly sufficient to separate the species. Prof. McCoy states that his shell differs from the British "in having the hinge-line rather longer, the anterior end more pointed, and the superior posterior angle rather more obtuse." The undoubted resemblance borne by Mr. Etheridge's fig. 4, Pl. 22, to the general figures of *Inoceramus problematicus*, D'Orb. (*I. mytiloides*, Mantell and Sby.), renders it necessary to unite it with McCoy's *I. Carsoni*. No absolute description of the Australian shell has yet ever appeared, comparison thereby becoming difficult.

The elongated, somewhat narrow form appears to be the chief character of the species. The shell of those examples I have referred to it is nearly a quarter of an inch thick, and the structure very coarsely fibrous.

*Loc.* Base of Walker's Table Mountain, Flinders River (*Messrs. Carson and Sutherland*—National Museum, Melbourne); Marathon Station, Flinders River (*The late R. Daintree*); ? Landsborough Creek, Thomson River (*Prof. A. Liversidge*—Colln. Sydney University); Flinders River, three miles above Richmond Downs Station, in drab limestone; and thirteen and a-half miles below the same, in an argillaceous limestone, with a cone-in-cone structure (*R. L. Jack*).

**INOCERAMUS SUTHERLANDI, McCoy.**

*Inoceramus Sutherlandi*, McCoy, Ann. and Mag. Nat. Hist., 1865, xvi., p. 334; *Ibid.*, 1867, xx., p. 196.

" " McCoy, Trans. R. Soc. Vict., 1866, vii., p. 50.

*Obs.* Prof. Sir F. McCoy refers to this shell as much larger and broader than *I. Carsoni*. "In form, size, and concentric undulations of the surface nearly agrees with the French and English common Cretaceous *I. Cuvieri*, but is less curved at the

\* Quart. Journ. Geol. Soc., 1872, xxviii., p. 183.

ventral margin near the beak, and rather narrower and more acute at the anterior end." *I. Cuvieri* is such a distinctive and well-marked shell that it is better to retain the present species separate.

*Loc.* Base of Walker's Table Mountain, Flinders River (*Messrs. Carson and Sutherland*—National Museum, Melbourne); Flinders River, three miles above Richmond Downs Station, in drab limestone; and twenty-one miles below the Station, in a similar rock (*R. L. Jack*).

**INOCERAMUS PERNOIDES, Etheridge, Pl. 25, figs. 7, 8, and 12.**

*Inoceramus pernoides*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 343, t. 22, f. 3.

*Sp. Char.* Shell quadrate, deep; umbonal region thick and elevated; beaks acute; anterior side slightly convex; the ventral margin broadly rounded; surface marked by alternating groups of fine and coarse concentric folds, or large undulations. (*Etheridge*.)

*Obs.* This shell much resembles *I. regularis*, D'Orb., in shape, size, and markings, but the wing or hinge-area is not so long. It is almost identical in shape with *I. Lamarckii*, *I. latus*, and *I. crispus*, Mant., but the concentric undulations are not so unequal and pronounced, neither had this shell a corrugated and thickened fold along the hinge-line, as in *I. Lamarckii*; the teeth or hinge-pits are not seen. It is evident that this is an abundant species in the Cretaceous rocks of Queensland, its remains being numerous and usually fragmentary. (*Etheridge*.)

A large shell (Pl. 42, f. 7) measuring six inches in length and four wide, the longest diameter being still incomplete, may perhaps be referred here. In its present state it is an internal cast, and is but indifferently figured.

*Loc.* Marathon Station, Flinders River (*The late R. Daintree*); Flinders River, seven miles above the same, in dark-drab limestone (*R. L. Jack*); Well, at two hundred feet below surface, seven miles east of Mount Cornish Homestead (*E. Edkins*).

**INOCERAMUS MARATHONENSIS, Etheridge.**

*Inoceramus marathonensis*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 343, t. 22, f. 1.

" " Etheridge fil., Journ. R. Soc. N. S. Wales, 1883, xvii., 1st pl., up. fig.

*Sp. Char.* Shell elongated and compressed; umbonal region narrow, acute, and tapering; ventral portion of shell much expanded; concentric plications or undulations variable, being alternately broad and narrow, and unequal. (*Etheridge*.)

*Obs.* In size and shape it somewhat resembles *I. annulatus* from the White Chalk of Westphalia; but the want of the true outer shell prevents our referring it to that species, the equidistant lines of growth in *I. annulatus* being characteristic and well defined. (*Etheridge*.)

This is retained provisionally as a species. The elongated form, and very coarse corrugations, with intermediate fine concentric lines appear to distinguish it. If *Inoceramus Sutherlandi*, McCoy, is after the type of *I. Cuvieri*, the present shell is a separate and distinct species, so far as Australian *Inocerami* are concerned.

*Loc.* Marathon Station, Flinders River (*The late R. Daintree*); Landsborough Creek, Thomson River (*Prof. A. Liversidge*—Colln. Sydney University).

**INOCERAMUS ELONGATUS, Etheridge.**

*Inoceramus multiplicatus*, Stoliczka, var. *elongatus*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 343 (*excl. ref.*), t. 22, f. 2.

*Sp. Char.* Shell much elongated, with numerous concentric ribs, which become coarser and flatter near the ventral margin; umbones acute and apparently incurved; whether they approximate or not, we have no means of determining. (*Etheridge*.)

*Obs.* The following remarks were made by Mr. Etheridge :—With the exception of being more elongated than the shell described by Dr. F. Stoliczka, our shell appears to be the same, allowing for those variations which the species in this genus exhibit. It is not so ventricose a shell as *I. striatus*, Mant., from the Lower Chalk of Sussex, Saxony, &c. (*Etheridge*.)

I fail to detect any direct resemblance between the figure of this bivalve and that of Stoliczka's *I. multiplicatus*.\* It will possibly simplify matters if it be known under its varietal name, elevated to specific rank, until more definite characters can be assigned to it than those quoted above.

The peculiarity of the concentric folds removes it from *I. problematicus* (D'Orb.) ; and as regards *I. multiplicatus*, it differs wholly in shape.

*Loc.* Marathon Station, Flinders River (*The late R. Daintree*).

#### INOCERAMUS CRIPSII, *Mantell*, ? Pl. 21, figs. 17 and 18.

*Inoceramus Cripsii*, Mantell, Foss. S. Downs, 1822, p. 133, t. 27, f. 11.

„ „ Zittel, Denks. K. Akad. Wissensch. Wien, 1866, xxv., Abth 2, p. 95, t. 14, f. 1-5, t. 15, f. 1-5.

„ „ F. Roemer, Kreidebild. Texas, 1852, p. 56, t. 7, f. 2.

„ *Crispianus*, Stoliczka, Pal. Indica (Cret. Fauna), 1871, iii., fas. 5-8, p. 405, t. 27, f. 1-3.

*Obs.* Several examples of an obliquely-oval oblong *Inoceramus* have been collected by Mr. S. Sharwood at Aramac Well, with coarse, distant, regular, and even corrugations, which I cannot with any degree of accuracy separate from this world-wide species, known as it is from Europe, India, and America (Texas).

The individuals are constant in size and shape, possessing a stronger resemblance to Prof. Zittel's excellent figures than they do to Stoliczka's of the Indian variety. We observe the straight hinges, oblique-oval form, prominent anterior, and almost terminal beaks, and the same angular, concentric, sometimes fluctuating corrugations, with intermediate finer striæ. The only difference which can be detected is the smaller and deeper anterior end, but, as I have not succeeded in entirely relieving a specimen from the matrix, the latter, and verified examples of *I. Cripsii*, cannot be compared in this direction.

There also exists a resemblance to *Inoceramus proximus*, Meek,† more especially in the smaller anterior end ; and a further comparison may be made with *Inoceramus problematicus*, var. *aviculoides*, Meek.‡

A small form of *Inoceramus* has been met with in a boring at Muttaborra. The outer shell has been removed, and the outline is not entire, but there are still traces of the usual corrugations. This may be the decorticated condition of *Inoceramus Cripsii*. It is certainly after that type.

*Loc.* Aramac Well, at depths of two hundred and thirty-eight feet and two hundred and forty-four feet, respectively (*S. Sharwood*) ; Muttaborra Bore (*J. B. Henderson*).

#### Family—PINNIDÆ.

*Genus*—PINNA, *Linnaeus*, 1758.

(Syst. Nat., Ed. x.)

PINNA, *sp. ind.*, Pl. 20, figs. 16 and 17.

*Obs.* Amongst the Walsh River fossils is the posterior end of a large *Pinna*, four and a-half inches long, with a width of three and a-quarter inches. The shell is

\* Pal. Indica (Cret. Fauna), 1871, iii., fas. 5-8, p. 406, t. 28, f. 1.

† Report U. S. Geol. Survey Ter., 1876, ix. (Invert Cret. Tert. Foss. Up. Missouri), p. 53, t. 12, f. 7a.

‡ *Loc. cit.*, p. 63, t. 9, f. 4.

more or less preserved, and bears indistinct, obtuse, longitudinal ribs, crossed by very fine imbricating lamellæ of growth. It is closely allied to *Pinna laticostata*, Stoliczka,\* from the Arrialoor Group of India, and may possibly be so to *Pinna australis*, Hudleston.†

*Loc.* Walsh River (*Hon. A. C. Gregory*).

#### Family—MYTILIDÆ.

*Genus*—*MYTILUS* (*Linnæus*), *Lamarck*, *emend.*, 1799.

(*Prodrome*—*Mém. Soc. Hist. Nat. Paris*, 1799, p. 88.)

#### *MYTILUS TENISONWOODSI*, *sp. nov.*

*Mytilus planus*, Moore, *Quart. Journ. Geol. Soc.*, 1870, xxvi., Pt. i., p. 252, t. 13, f. 3.

*Sp. Char.* Shell small, thin, ovate, compressed, nearly equilateral; umbones terminal and acute, ventral margin rounded; dorsal surface smooth, with depressed concentric lines of growth, crossed by very fine radiating lines, which wholly cover the exterior. Its flattened form, with its distinct ornamentation, readily distinguishes the species. (*Moore*.)

*Obs.* The specific name applied by Mr. Moore to this shell had already been twice used before in the same sense. Eichwald employed it in the first instance for a supposed Palæozoic *Mytilus*, but afterwards referred the shell to *Avicula*.‡ Klöden has likewise used the name *planus* for a Mesozoic *Mytilus*,§ and under these circumstances less confusion will be caused by changing it than by retaining it for the above shell. The name of the late Rev. J. E. Tenison Woods may appropriately be associated with it, as a very slight recognition of his labours in Queensland Palæontology.

As the interior of this shell is entirely covered with radiating lines, it may perhaps be referable to the genus *Orenella*, rather than to *Mytilus* proper.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

#### *MYTILUS RUGOCOSTATUS*, *Moore*.

*Mytilus rugocostatus*, Moore, *Quart. Journ. Geol. Soc.*, 1870, xxvi., p. 252, t. 13, f. 2.

*Sp. Char.* Shell thick, ovately oblong; umbones terminal and acute; posterior margin oblique and curved; anterior side produced and somewhat rounded; the dorsal surface is obtusely keeled, and towards the umbo has very coarse irregular concentric striæ or lines of growth, which become finer towards the ventral margin. (*Moore*.)

*Obs.* Unlike the *Mytilidæ* generally, whose shells are usually thin and fragile, this species possesses a very thick test, especially in adult examples. When a portion of the test has adhered to the matrix, leaving an inner layer exposed on the shell, the striæ are not seen, and the surface appears smooth, giving it the appearance of an entirely different species. (*Moore*.)

Mr. G. Sweet has found at Bungeworgorai Creek, a *Mytilus*, two and a-half inches long, which is probably this species.

I suspect that the *Mytilus*, sp.,|| recently figured by Mr. Hudleston from the Lake Eyre Basin is but a well preserved cast of the present species.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*); Bungeworgorai Creek (*G. Sweet*—*Colln. Sweet*, Melbourne).

\* *Pal Indica* (*Cret. Fauna*), 1871, iii., p. 385, t. 25, f. 2 and 3.

† *Geol. Mag.*, 1890, vii. (3), p. 244, t. 9, f. 6.

‡ *Lethæa Rossica*, ii., p. 946.

§ *Verstein. Mark Brandenburg*, 1834, p. 207, t. 3, f. 4.

|| *Geol. Mag.*, 1890, vii. (3), p. 245, t. 9, f. 9.

## MYTILUS INFLATUS, Moore, Pl. 25, fig. 11.

*Mytilus inflatus*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 252, t. 13, f. 4.

? " " Ten. Woods, Journ. R. Soc. N. S. Wales, 1882 [1883], xvi., p. 153, t. 10, f. 8.

*Sp. Char.* Shell smooth, slightly inequivalve, convex, both valves inflated; margins close-set; umbones terminal, acute, anterior; hinge-line extended and oblique; posterior margin and front rounded; dorsal surface smooth, with irregular concentric bands of growth. (Moore.)

*Obs.* "This pretty little shell is to be distinguished by its very inflated appearance, its more extended hinge-line, and terminal umbones. Its test still retains some colour." (Moore.)

The specific name of this species was preoccupied by Müller before it was made use of by Mr. Moore, but the species described by the former is referable to another pre-existing species,\* wherefore the name ascribed by Mr. Moore to the Australian shell will probably stand.

The late Rev. J. E. T. Woods believed *M. inflatus* to be of Oolitic age. There is, however, no absolute reason for considering it as so differing from the other fossils with which it is associated.

Although represented as a longer shell, I think that Mr. Hudleston's *Modiola linguloides*† is only a variety of the present species, and I notice that Prof. R. Tate places it as a synonym,‡ and more recently still this is admitted by Mr. Hudleston.§ It is very abundant in the Lake Eyre Beds, and I had an opportunity of examining a large series forwarded to the Indian and Colonial Exhibition by Mr. H. Y. L. Brown. Mr. Tenison Woods' figure represents a still larger individual, and one posteriorly so much more lengthened than Moore's figure, that I would prefer for the present to withhold a conclusive opinion as to its identity. Between the bands of growth the shell is covered with very delicate concentric striae. I was indebted to the late Mr. Tenison Woods for the loan of his figured specimen.

*Loc.* Wollumbilla (The late Rev. W. B. Clarke); Palmer River (The late Rev. J. E. T. Woods).

## MYTILUS INGENS, Ten. Woods.

*Mytilus ingens*, Ten. Woods, Proc. Linn. Soc. N.S. Wales, 1882, vii., Pt. 3, p. 389.

*Sp. Char.* Shell oblong, oval or elliptical, tumid, or gibbous in the centre, so as to form an arched, broad, regularly sloping carina, depressed at the anterior side; thick, but not clumsy, at the posterior margin; the whole very equally sulcate with lines of growth, the younger ones deep-ridged and with a beautiful curve, the latter less distinct. Umbones terminal, small, corroded, curved. Ligamental fossa somewhat small, broad, terminal, shallow, with a long, narrow slit for the byssus. Pallial impression long and wedge-shaped. Length thirty centimetres, breadth nineteen, height seventeen, length of hinge depression nine. (Ten. Woods.)

*Obs.* This appears to be a very large species, and distinct from either of those described by the late Mr. C. Moore from the Wollumbilla blocks, although in form it approaches *M. inflatus*, Moore.

*Loc.* Barcoo District (The late Rev. J. E. T. Woods).

\* See Stoliczka, Pal. Indica (Cret. Fauna), 1871, iii., fasc. 5-8, p. 373.

† Geol. Mag., 1884, i., p. 341, t. 11, f. 6 a-b.

‡ Proc. Austr. Assoc. Adv. Sci. for 1888 [1889], i., p. 230.

§ Geol. Mag., 1890, vii. (3), p. 245.

*Genus—MODIOLA, Lamarck, 1799.*

(Prodrome—Mém. Soc. Hist. Nat. Paris, 1799, p. 87.)

*MODIOLA UNICA, Moore.**Modiola unica*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi, p. 253, t. 13, f. 5.

*Sp. Char.* Shell small, smooth, obtuse, convex, thickest at the umbones; umbones subterminal; hinge-line straight; anterior side produced and rounded; dorsal surface, with a few flattened concentric striae, which are decussated by very faint longitudinal lines. (*Moore.*)

*Obs.* This shell has much the appearance of a *Lithodomus*.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke.*)

**Order—UNIONACEÆ.****Family—UNIONIDÆ.***Genus—UNIO, Phillipson, 1788.*

(Dissert. His. Nat. Nov. Test. Genera, p. 26.)

*Obs.* Two specimens of *Unio* were obtained from the sinking of the Government Well at Winton. The specimens seem to be distinct from one another, and are both small forms. They were presented to the Geological Survey Museum by Mr. Julius von Berger.

**Order—ARCACEÆ.****Family—ARCIDÆ.***Genus—ARCA, Linnæus, 1758.*

(Syst. Nat., Ed. x., i., p. 693.)

*ARCA PRÆLONGA, Moore, Pl. 33, fig. 7.**Arca praelonga*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi, p. 249, t. 14, f. 7.

*Sp. Char.* Shell transverse, inequilateral; umbones rather close, anterior; hinge-line long, with numerous close-set teeth; posterior side extended and slightly angulated, with a depressed keel crossing from the umbo to the posterior ventral margin. (*Moore.*)

*Obs.* Had it not been for the mention of "close-set teeth," I should have considered the reference of this shell to *Arca* very doubtful.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke.*)

*Genus—CUCULLÆA, Lamarck, 1801.*

(Syst. Anim. sans Vertéb., p. 166.)

*CUCULLÆA HENDERSONI, sp. nov., Pl. 26, figs. 2 and 3.*

*Sp. Char.* Shell small, obliquely oblong, gibbous; cardinal margin straight; the area seems to have been wide, and on casts are visible the impressions of three lateral teeth, a little oblique to the margin. Umbones prominent, projecting, gibbous, slightly more anterior than median; anterior end moderately large, sharp-angled; posterior end rather larger than the anterior, obliquely truncated, with a well-marked diagonal ridge and posterior slope, with a simple and not emarginate margin; ventral margin nearly straight medianally. Surface with somewhat strong concentric lines, apparently crossed by radiating striae.



*Obs.* This is a small and neat species, and quite different from any other member of this family yet described from Queensland rocks. It is named in honour of Mr. J. B. Henderson, Hydraulic Engineer to the Queensland Government, who has been kind enough to contribute several species for the illustration of this work.

*Loc.* North-east end of Glanmire Block, seventeen miles south-west of Tambo (*Mr. Goffage*).

### Family—NUCULIDÆ.

*Genus*—*NUCULA*, *Lamarck*, 1799.

(*Prodrome*—*Mém. Soc. Hist. Nat. Paris*, 1799, p. 87.)

*NUCULA QUADRATA*, *Etheridge*, Pl. 26, figs. 8 and 9.

*Nucula quadrata*, *Etheridge*, *Quart. Journ. Geol. Soc.*, 1872, xxviii., p. 341, t. 19, f. 5, t. 20, f. 3.

*Obs.* This species, hitherto only known from the Desert Sandstone of Maryborough, is described under the head "Desert Sandstone," to which the reader is referred. It has, however, been found in the Rolling Downs Formation, in the Aramac Town Well, at the depth of two hundred and forty-four feet, by Mr. S. Sharwood, by whom it was presented to the Geological Survey.

*NUCULA COOPERI*, *Moore*, Pl. 34, fig. 11.

*Nucula Cooperi*, *Moore*, *Quart. Journ. Geol. Soc.*, 1870, xxvi., p. 251, t. 12, f. 8.

*Sp. Char.* Shell trigonal, very convex; umbones rather anterior, widely separated; anterior side angular, posterior side rather produced and attenuated; ventral margin rounded. (*Moore*.)

*Obs.* This shell, for a *Nucula*, attains considerable size. It may be distinguished from *Nucula quadrata*, *Eth.*, and *N. gigantea*, *Eth.*, apparently by its more deltoid form.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

*NUCULA TRUNCATA*, *Moore*, Pl. 33, fig. 9.

*Nucula truncata*, *Moore*, *Quart. Journ. Geol. Soc.*, 1870, xxvi., p. 254, t. 12, f. 9.

*Sp. Char.* Shell triangular; umbones anterior, compressed; anterior side very truncated; dorsal margin rounded; hinge-line with about seven large teeth on the posterior side of the umbo, and with four or five on the anterior side. (*Moore*.)

*Obs.* According to Mr. Moore, *N. truncata* is readily distinguishable from *N. Cooperi* by its more compressed form and truncated margin.

The name must not be mistaken for a similar one used by Nilsson, for a shell which is now usually referred to *Nucula pectinata*, *Sby*. I find, from South Australian examples forwarded to me by Prof. R. Tate, that there is a marked posterior slope and apparently a wide and long heart-shaped lunule.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

*NUCULA AUSTRALIS*, *Moore*, sp.

*Leda australis*, *Moore*, *Quart. Journ. Geol. Soc.*, 1870, xxvi., p. 251, t. 12, f. 7.

*Sp. Char.* Shell transversely ovate; umbones anterior, contiguous, compressed; anterior side rounded, posterior side longest, attenuated; hinge-teeth small, numerous; dorsal surface covered with numerous transverse striæ. (*Moore*.)

*Obs.* Although described as a *Leda* by Mr. Moore, this shell has quite as much the appearance of *Nucula*, to which it is now referred. The description will apply to either genus, and, like many of Moore's species, the shell is too loosely diagnosed to be easily recognisable.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

NUCULA, *sp. ind.*

*Obs.* Another species, apparently differing from any of the foregoing, has been obtained during the sinking of the Aramac Well. It is only known in the condition of an internal cast; but this is trigonal, with a semi-pointed posterior end, a straight posterior hinge, and numerous small teeth. The muscular impressions are strongly marked, the anterior being situated low down, whilst a single row of dot-like scars (retractor impressions?) are ranged from the umbonal cavity to the posterior adductor. The margins are apparently plain.

A very similar shell to this is *Nucula planimarginata*, Meek,\* from the Fox Hills Group, of the Missouri Cretaceous.

In form this species is not unlike *N. pectinata*, Sby., of the European Gault, but we know nothing of the ornament as a further means of comparison.

*Loc.* Aramac Well, at two hundred and forty-four feet deep (*S. Sharwood*).

Family—TRIGONIADÆ.

Genus—TRIGONIA, Bruguière, 1789.

(Encycl. Method., i., Pl. 14.)

TRIGONIA LINEATA, Moore.

*Myophoria*, *sp.*, McCoy (*vide* Moore), Trans. R. Soc. Vict., 1865, vi., p. 44.

*Trigonia lineata*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 255, t. 13, f. 12.

„ „ Lycett, Mon. Brit. Foss. Trigoniæ, 1879, No. 5, p. 224.

*Sp. Char.* Shell thick, equivalve, inequilateral, gibbous, as broad as long; umbones convex, recurved towards the anterior margin; anterior side and ventral margin rounded; posterior angle somewhat rounded; marginal carinæ absent; shell gradually sloping to the front; surface with close-set regular transverse concentric striæ, about twenty in number, which on the anterior margin possess depressed tubercles. (*Moore*.)

*Obs.* Mr. Moore was the first to point out that McCoy's *Myophoria* was in reality a *Trigonia*, and he, in accordance with this view, proposed for it the above name, comparing it with the European Portlandian species, *Trigonia gibbosa*. It was from the supposed presence of this *Myophoria* that McCoy suggested the occurrence of the Rhætic Formation in Australia, but it "does not possess the oblique keel and the acute posterior side" of that genus.

It is more than likely that the late Dr. Lycett was correct when he compared *T. lineata* with the Indian Cretaceous species *T. orientalis*, Forbes,† and *T. suborbicularis*, Forbes,‡ rather than to an Oolitic species, as suggested by Moore. In fact, Lycett believed *T. lineata* to have a strongly Cretaceous aspect.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

TRIGONIA MESEMBRIA, Ten. Woods.

*Trigonia mesembria*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 2, p. 237, t. 12, f. 1-3.

*Sp. Char.* Shell ovately oblong, tumid, very convex; umbones somewhat anterior, not recurved; superior border moderately convex, rather elongate; posterior border curved, slightly truncate at the siphonal margin; anterior border tumidly produced and rounded; posterior groove wide, conspicuous, shallow, widening rapidly from the umbones to the margin; costæ irregular, not prominent, some smaller ones occasionally intercalated, all passing horizontally across the valve, slightly undulating anteriorly,

\* Report U.S. Geol. Survey Ter., 1876, ix. (Invert. Cret. Tert. Foss. Up. Missouri), t. 15, f. 8a-b.

† Trans. Geol. Soc., 2nd Ser., vii., p. 150, t. 18, f. 11.

‡ *Ibid.*, p. 150, t. 18, f. 10.

disappearing on the posterior groove; siphonal ridge smooth, with three narrow rounded ridges, three rather wide shallow grooves between, which become faint as they widen towards the margin; escutcheon long, ovate, with a flat groove on each side, striæ on the lower part, the rest smooth, margins raised; hinge teeth thick, large, prominent, with two grooves on the upper edge, and about thirteen close, neat, parallel lateral grooves; shell thick. (*Ten. Woods.*)

*Obs.* Although this shell was described from a New South Wales locality, the latter is so near the Queensland border that it is thought advisable to include it here.

*T. mesembria*, Mr. Woods states, is one of the group *Glabra*, or smooth *Trigonia*, and approaches nearest in its form to *T. dunscombensis*, Lycett, from the British Upper Greensand. It is said to be quite distinct from the other Australian species *T. Moorei*, Lycett, *T. lineata*, Moore, and *T. nasuta*, Eth., although in outline nearest to the latter.

*Loc.* Mount Stewart Run, Grey Ranges, New South Wales, near the South Australian and Queensland borders (*The late Rev. J. E. T. Woods*—Colln. Woods).

TRIGONIA, *sp. ind.* (b), Pl. 21, fig. 21.

*Obs.* A small and fragmentary but well-defined valve apparently of a *Trigonia* is represented in Pl. 21, fig. 21. The interior is exposed, but unfortunately the umbo and cardinal margin have disappeared. It possessed a ventricose appearance, a much attenuated posterior end, a strongly marked diagonal ridge, and a large posterior slope for the size of the valve. The latter appears to have borne three, or perhaps more, well-defined ridges. The interior is highly nacreous, and when this layer is removed the external impression of the shell is visible with strong concentric ridges.

This form has a strong resemblance to a small and peculiar species, *T. semiornata*, figured by A. D'Orbigny from the Cretaceous rocks of South America.\*

*Loc.* Blackall Road, nine miles from Tambo, accompanied by Belemnites, in a shelly limestone (*R. L. Jack*).

#### Family—ASTARTIDÆ.

*Genus*—*ASTARTE*, *J. Sowerby*, 1816.

(*Min. Con.*, ii., p. 85.)

*ASTARTE WOLLUMBILLENSIS*, *Moore*, Pl. 27, fig. 16.

*Astarte wollumbillensis*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 250, t. 12, f. 12.

*Sp. Char.* Shell small, thick, ovately orbicular, gibbous; umbones large, mesial; posterior side rather extended, anterior slightly oblique; ventral margin rounded; shell covered with numerous regular concentric rugæ, with deepish interspaces, and with three or four interrupted folds of growth. (*Moore.*)

*Obs.* The generic relations of this species are still quite an open question. Moore's description and figure do not throw any light upon them.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

#### Order—LUCINACEA.

##### Family—LUCINIDÆ.

*Genus*—*CORBICELLA*, *Lycett*, 1857.

(*Handb. Cotteswold Hills*, p. 128.)

*CORBICELLA* ? *MARANOANA*, *sp. nov.*

Pl. 27, figs. 4 and 5; ? Pl. 28, figs. 2 and 3.

*Sp. Char.* Shell elongately oval, rather pod-shaped, with a slight obliquity to the posterior, almost equilateral; valves gently convex, not inflated nor gibbous; dorsal

\* Dumont D'Urville's Voy. au Pole Sud Geologie, Atlas, 1847, t. 7, f. 31.

margin long, nearly straight; ventral margin rounded at either end, almost straight along the centre. Anterior end nearly equal to the posterior, the roundly truncate margin obliquely curved upwards, giving to the shell the described obliquity, the posterior only differentiated by its greater length. Umbones nearly central. Dorsal or hinge margin thickened with an anterior cardinal tooth, large, solid, and somewhat triangular, posterior cardinal tooth but little developed. Concentric lines of growth very regularly follow the outline, turning sharply towards the umbones on the anterior slopes, and curving rather obliquely up on the posterior end, but the shell is in reality nearly smooth.

*Obs.* This shell has given more trouble in its determination than any other in the whole Collection, and is referred to the present genus with great doubt; it is probably the type of an undescribed genus. In Pl. 27, fig. 4, the anterior end has been broken away, and on that account much of the anterior obliquity is lost, but this is apparent in Pl. 28, fig. 2, which, I believe, is only the internal cast of *Corbicella maranoana*. This peculiar obliquity towards the posterior recalls the genus *Cercomya* to some extent, but there is an entire absence of the strong diagonal ridge and posterior slope of that genus. The upturning of the posterior dorsal margin arises from a peculiarity of the cast, and is perhaps structural, being probably the edge of the interior of the valves below the thickened hinge plate. It may, perhaps, be doubted if Pl. 28, f. 2 and 3, are the internal cast of Pl. 27, fig. 4, but there is a depression beneath the beaks in an example of the former answering to that visible in Pl. 27, fig. 5, and, as already explained, the anterior end of Pl. 27, fig. 4, is a good deal broken away. This species exists in Prof. Tate's Collection from South Australia, and is termed by him *Poromya*, but it does not coincide with the original type of that genus. Prof. Tate's specimens and others from the cabinet of Mr. G. Sweet will eventually be figured.

After considerable hesitation I provisionally refer this peculiar shell to Lycett's genus *Corbicella*, from the fact that the structure of the hinge seems to agree better with that of the latter than with any other genus. The shell may readily be known by its ovoid, lengthened, smooth form. In these particulars, more especially the two last, it has considerable resemblance to some Oolitic species of *Corbicella*, but in the case of a shell like the present, in which the hinge is only partially preserved, it is necessary to speak with caution.

*Loc.* Maranoa River, half a mile above Mitchell Railway Station, in a core of limestone (*R. L. Jack*; *G. Sweet*—Colln. Sweet, Melbourne).

*Genus*—*UNICARDIUM*, *D'Orbigny*, 1850.

(Prod. Pal. Strat., i., p. 218.)

*UNICARDIUM MEEKI*, *sp. nov.*

Pl. 27, figs. 2 and 3; ? Pl. 26, figs. 13-15.

*Sp. Char.* Shell gibbous, ovate-trigonal; cardinal margin angular; umbones obtuse, a little elevated, with the beaks close and approximate. Anterior side rounded, somewhat produced; posterior end produced, becoming rather pointed at the posterior ventral angle; posterior slope flattened; ventral margin forming a broad semi-oval curve. Anterior muscular scar narrow-ovate, pointed above, with its posterior margin elevated and ridge-like. Pallial line indistinct; surface marked with fine lines of growth, which appear to widen out into flatter ridges on the body of the shell.

*Obs.* It was not until I had examined Prof. Tate's Collection of South Australian Cretaceous fossils that I was able to make out the generic relations of this species, through a knowledge of the internal hinge characters, having previously referred the type (Pl. 27, figs. 2 and 3) to the genus *Mactra*.

In the left valve of *U. Meeki* the conical cardinal tooth is well marked and prominent, with a deep socket on its posterior side for the reception of the tooth of the right valve.

*Unicardium cardioideum*, Phillips,\* has similar wide concentric lines of growth to the present species.

In a future publication the hinge structure of this species will be figured.

*Loc.* Walsh River (*Hon. A. C. Gregory*).

## Order—VENERACEA.

### Family—VENERIDÆ.

#### *Genus—CYTHEREA, Lamarck, 1806.*

(*Ann. Mus. Hist. Nat. Paris*, vii., p. 132.)

#### *CYTHEREA WOODWARDIANA, Hudleston, Pl. 27, figs. 12-14.*

*Cytherea Woodwardiana*, Hudleston, *Geol. Mag.*, 1884, i., p. 340, t. 11, f. 8a-c.

*Sp. Char.* Shell oval, compressed, veneriform, longer than broad. Hinge-line inclined on both sides; dentition unknown; umbones small, quite approximate; lunule almost imperceptible, nearly flat; ligament small, but prominent. Ventral margin regularly rounded. Anterior end small, the margin gracefully rounded; posterior end rather more produced than the anterior. Pallial sinus large, and much sinuated for so small a shell, the first turn from the anterior towards the posterior end, forming a very sharp angle. Surface with about five broad, concentric, flat undulations, between which are very fine close striæ, having a similar direction, and the whole crossed by fine radiating striæ.

*Obs.* I cannot agree with Mr. W. H. Hudleston in saying that the radiating striæ are irregular. On the examples examined these lines were quite normal. This character and the compressed nature of the valves are excellent features for the determination of the species. On removal of the outer shelly layer, the radiating striæ, it is true, quite disappear.

The inflection of the hinge calls to mind the structure of the genera *Cyprimeria* and *Caryatis*, rather than that of a true *Cytherea*, especially such species as *Cyprimeria gaultina*, Loriol.†

#### *CYTHEREA ? HUDLESTONI, sp. nov., Pl. 28, fig. 12.*

*Sp. Char.* Shell ovately trigonal, rather acuminate towards the umbones, tumid; body of the shell convex, which is more or less maintained to the ventral margin, not thinning away rapidly to the latter; hinge margin much arched; ventral margin rounded; posterior margin slightly angulated; posterior slope broad and rounded; surface with regular, concentric, sub-imbricating laminae.

*Obs.* A very obscure shell, not easily defined, but important as forming considerable rock masses, associated with *Actæon depressus*, Moore?, *Cucullæa Hendersoni* (mihi), *Dentalium*, and other shells.

The nature of the hinge is unknown, and the shell does not possess any very distinctive characters beyond its shape. It is an undoubted specific addition to the

\* *Ill. Geol. York.*, 3rd Edit., Part i., 1875, t. 14, f. 12.

† *Mém. Soc. Pal. Suisse*, x., p. 35, t. 7, f. 1-5.

Australian Mesozoic list, and I have much pleasure in associating with it the name of Mr. Hudleston, whose labours amongst the Secondary Mollusca are much appreciated. It is provisionally placed in *Cytherea* at the suggestion of Mr. J. Brazier.

*Loc.* North-east end of Glanmire Block, seventeen miles south-west of Tambo (*Mr. Goffage*).

*CYTHEREA (CYPRINA?) MOOREI*, *sp. nov.*, Pl. 34, figs. 12 and 13.

*Cyprina? sp.*, Hudleston, *Geol. Mag.*, 1884, i., p. 341, t. 11, f. 7a and b.

*Sp. Char.* Shell ovate, width and length nearly equal, hinge-line or cardinal margin sloping sharply on both sides; ventral margin regularly rounded, anterior end short; posterior end obtusely pointed. Lunule probably long and moderately deep. Umbones but little incurved; umbonal region obtuse, the test much thickened thereabouts; flanks compressed towards the ventral margin. Sculpture of surface unknown.

*Obs.* I am unacquainted with the nature of the hinge, thus leaving the question of its generic position, whether *Cytherea* or *Cyprina*, an open one. An examination of Mr. Hudleston's type showed that the "concentric bands at intervals" are simply eroded layers of shelly matter, the surface, in all probability, having been comparatively smooth. Both the original description and figure are therefore in this respect misleading. The preservation of the type certainly does not permit of it being said—"lunule wide and deep, ligamentary excavation wide and short," for these portions of the specimen are not in a condition favourable for description. The lunule was long, but not particularly deep.

A specimen (Pl. 26, figs. 11 and 12) has been presented to the Queensland Geological Survey Collection by Mr. Rowland Morrisby, which appears to correspond closely with Mr. Hudleston's species, but it presents a slightly different aspect on account of the preservation of the umbo, which gives the specimen a rather higher and less robust appearance.

*Loc.* Evora Station, twenty-five miles north-east of Blackall (*R. Morrisby*); Peak District, South Australia (*H. Y. L. Brown*—*Nat. Hist. Museum, London*)—Lake Eyre Beds.

Family—CYPRINIDÆ.

*Genus*—*CYPRINA*, *Lamarck*, 1818.\*

(*Hist. Anim. sans Vertéb.*, v.)

*CYPRINA CLARKEI*, *Moore*, *sp.*

Pl. 27, fig. 9; ? Pl. 26, figs. 18 and 19; ? Pl. 27, figs. 10 and 11.

*Cytherea Clarkei*, *Moore*, *Quart. Journ. Geol. Soc.*, 1870, xxvi., p. 250, t. 13, f. 1.

*Cyprina cyprina*, *Etheridge*, *Quart. Journ. Geol. Soc.*, 1872, xxviii., p. 338, t. 19, f. 1.

*Sp. Char.* Shell large, thick, rather compressed, transversely ovate, inequilateral, moderately convex; umbones flattened, incurved over a large and rounded lunule; anterior and posterior ends and dorsal margin rounded; surface of the shell with broad irregular transverse bands of growth. (*Moore*.)

*Obs.* Unfortunately Mr. Moore's description of this important shell is most inadequate for its correct determination, and the figure is little better. As represented, it would convey to the eye the idea of a shell possessing a very concave anterior hinge, and a much arcuated and obliquely directed posterior hinge-line. Along the latter line, however, the specimen figured was clearly defective. During a comparatively recent

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\* Probably proposed in 1812, in the "Cours de Zoologie."

conversation with Prof. R. Tate, he expressed the opinion that this species was identical with *Cyprina expansa*, Etheridge. It is, of course, extremely difficult to arrive at a definite conclusion when dealing with such imperfect material, and when also the types are not before us; but, allowing for discrepancies of outline, I find myself quite in accord with so authoritative an opinion. In *Cyprina expansa* the umbones are quite anterior, and projecting forwards prominently; the curve of the anterior hinge from the umbones is short, and the posterior hinge-line more or less horizontal, giving to the shell, with its other features, a somewhat quadrangular aspect. On the other hand, in *Cytherea Clarkei* the umbones are some way removed from the anterior end; the curve of the anterior hinge is long and open; whilst the posterior hinge rapidly descends in an oblique curve, although, as before stated, this portion of Moore's specimen was clearly defective. At any rate, this is the view the appearance of the figures would appear to justify.

More closely resembling Moore's figure are those given on our Plate 27 (figs. 10 and 11), although representing a smaller shell. The specimens are of medium size, rotund-ovate, longer than high, and with no great convexity of valves. The hinge was arcuate, especially on the posterior side, and the ventral margin well rounded; umbones moderately convex and close together, incurved, and rather more anterior than posterior. The muscular impressions are well marked, especially the anterior, whilst the pallial line was deeply and widely sinuated. Portions of the shell are preserved showing that the surface bore fine regular, raised, concentric lines, here and there broken by a more marked interruption of growth, and on the anterior end crossed by a few oblique similar lines, but not on other portions of the test.

If the two shells (Pl. 27, figs. 10 and 11) are not *Cytherea Clarkei*, I am at a loss as to their identity, and can only arrive at the conclusion that they are an unnamed species of *Cytherea*, so far peculiar to the Queensland beds. The less transversely elongated and arcuate outline will distinguish them from the species here called *Macrocallista Taylora*. *Cytherea Clarkei* evidently attains a considerable size. "It is one of the largest of Australian bivalves," says Mr. Moore, "and appears to have attained a large size, even for a *Cytherea*. . . . The largest example measures six and a-quarter inches in breadth by four and a-quarter inches in depth."

In addition to this species Mr. Moore alluded to a second, under the name of *Cytherea gibbosa*, with the following brief remarks:—"A second species, much more convex and gibbous, with umbones much thickened, is present, but the specimen is too imperfect for description. It is from Wollumbilla." This was not figured, and as it is impossible to recognise a species from such a description, the name had better be expunged from the list.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*); Maranoa River (*Ibid.*); Gregory River, north of Finnis Springs (*Ibid.*); Upper Flinders River (*Hon. A. C. Gregory*); Walsh River, Pl. 27, figs. 9 and 11 (*Hon. A. C. Gregory*); Minmi, near Roma (*R. L. Jack*). Also recorded by Prof. R. Tate,\* from Cootanooka, thirty or forty miles north-west of the Peake, Central Australia, and from the Peake.

*Genus*—*CALLISTA*, *Poli*, 1791.

(Test. Utr. Sicil.)

*Section*—*MACROCALLISTA*, *Meek*, 1876.

(Invert. Cret. and Tert. Foss. Up. Missouri Country, p. 179.)

*Obs.* It is more than probable that this section of *Callista* exists in the Queensland Cretaceous. The excellent remarks of the late Mr. Meek in reference to the proper

\* Trans. R. Soc. S. Austr. for 1879-80 [1880], iii., p. 179.

restriction of Poli's genus, as typified by *Venus chione*, Linn., will prove to be of great assistance to all workers. *Macrocallista* was proposed by Meek to include forms resembling *Venus gigantea*, Gmelin. The shell is transversely elongate-oval, with a more or less smooth surface. The pallial sinus is deep, resembling that of *Callista* proper, but the details of the hinge differ to some extent.

MACROCALLISTA PLANA, Moore, sp., Pl. 27, figs. 6-8.

*Myacites planus*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 254, t. 12, f. 10.

*Sp. Char.* Shell transversely elongated, somewhat compressed, length about one and three-quarters that of the height; anterior end rounded and narrowed; posterior side elongated and pointed; dorsal margin gently curved posterior to the umbones; ventral margin forming an open-free curve; umbones subcentral, nearer the anterior end; muscular impressions round or oval, usually well marked; pallial sinus very deeply indented. Surface nearly smooth, with very fine concentric lines of growth, becoming broader towards the ventral margin; character of the hinge, lunule, and escutcheon not ascertained.

*Obs.* I have been unable to satisfactorily refer this shell to any known genus of Cretaceous Bivalves, from the obscure preservation of the hinge and teeth. An internal cast shows that it possessed both cardinal and lateral teeth, apparently after the type of the Veneridæ, but more than this cannot be said. In outward appearance the shells closely resemble those which Mr. Meek has proposed to separate as *Macrocallista*, but the umbones are rather too tumid, and hardly project far enough forward. The species is not allied to any of those referred to *Callista* by Stoliczka from the Indian Cretaceous series. On the other hand, it has much the appearance of a shell called *Myacites* by Mr. R. Etheridge, F.R.S.,\* from the Gordon Downs. The shell in question is not a *Myacites*; it has no characters in common with that genus, and of this Mr. Etheridge is himself now satisfied. In all probability it is the species under description, and as to the horizon stated—viz., Lower Oolite—the beds in which the fossil was found certainly form a portion of the "Rolling Downs Formation." Reference may be made in passing to *Myacites planus*, Moore, from Wollumbilla, which presents a resemblance to our shell, but is perhaps shorter from side to side, the former being longer in proportion to its width. The Collection contains other imperfect and unnameable casts which may, perhaps, be referable to the present genus, but absolute certainty cannot be affirmed.

Judging from Moore's figure, *Myacites planus* does not appear to be congeneric with those on which Schlotheim established the genus *Myacites*.

*Loc.* Walsh River (*Hon. A. C. Gregory*); Wollumbilla (*The late Rev. W. B. Clarke*).

Family—CARDIIDÆ.

Genus—*LEVICARDIUM*, Swinson, 1840.

(Malacology, p. 373.)

*LEVICARDIUM BRAZIERI*, sp. nov.†

*Sp. Char.* Shell large, ovate, convex and gibbous, almost equilateral; test thick; dorsal margin short, curved; umbones nearly central, gibbous; anterior and posterior ends almost equal, but the latter a little more produced, their margins and that of the ventral round, and running into one another; anterior slope rather flattened,

\* Quart. Journ. Geol. Soc., 1872, xxviii., p. 348.

† This shell will be figured in a Supplement to the present Work.



posterior hardly developed; general contour from the umbones to the ventral margin, convex and well rounded. Surface smooth, with the exception of very delicate, scarcely defined, concentric lines, more apparent towards the ventral margin, and there are the faintest indications of radiating lines, more marked on the anterior and posterior sides.

*Obs.* This large and well-marked shell was communicated by the late Rev. J. E. T. Woods, and although the locality has been mislaid it is unquestionably a Queensland shell. It is in a shelly limestone associated with a large number of *Nuculae*.

The nearly central position of the beaks and oval outline give it a very equilateral appearance, added to which the practically smooth surface renders it a species not easily forgotten. The dental characters are unknown, but were probably powerful, judging from the thick and strongly made shell. The radiating ribs would hardly be worthy of notice were it not that, when the test is weathered these appear in its substance very distinctly, and when crossed by the fine concentric lines break up the shelly matter into small quadrangular spaces, as frequently seen in some of the *Cardiidae*.

The only species I can at all compare with the present one is *Cardium imbricatarium*, Leymérie, as figured by Eichwald.\* The shape is the same, and there is a resemblance in the absence of sculpture and radiating ribs, although the last-named species has three along the position of the posterior slope. In our species the concentric laminae are very fine and close together, but in Leymérie's species they are broad and somewhat distant.

The exact locality has been mislaid, but Mr. Woods informed me that it was without doubt collected in Queensland.

It is named in honour of Mr. John Brazier, C.M.Z.S., Conchologist to the Australian Museum, to whom the Writer is indebted for cheerfully rendered assistance.

*Loc.* Queensland (*The late Rev. J. E. T. Woods*—Colln. Woods).

### Family—DONACIDÆ.

#### *Genus*—*TANCREDIA*, Lycett, 1850.

(Ann. and Mag. Nat. Hist., vi., p. 407.)

*Obs.* Two Australian Mesozoic shells have been referred to this very well-marked genus, *Tancredia plana*, Moore, and *Tancredia*, *sp. ind.* (Etheridge). They are so retained in deference to the opinion of such well-known Authorities in Secondary Palæontology, although neither shell corresponds in outward appearance with the type species of *Tancredia*, *T. donaciformis*, Lycett, or with the next described form *T. extensa*, Lycett. The hinge characters of the Australian shells are not known.

#### *TANCREDIA* ? *PLANA*, Moore.

*Tancredia plana*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 254, t. 13, f. 13.

*Sp. Char.* Shell thin, smooth, flattened, transversely ovate, rather inequivalve; anterior side rounded; posterior margin oblique; surface of the shell covered by very fine transverse striations. (*Moore*.)

*Loc.* Blythesdale, fifteen miles from Wollumbilla (*The late Rev. W. B. Clarke*).

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\* *Lethæa Rossica*, ii., p. 682, t. 25, f. 11.

TANCREDIA ? *sp. ind.*

*Tancredia, sp.?* Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 348, t. 25, f. 8.

*Obs.* Mr. R. Etheridge, F.R.S., compared this shell to *Corbicella bathonica*, Morris and Lycett, an indication which appears to be strongly in favour of its reference to that genus rather than to *Tancredia*. So far as the mere outline is concerned, it may be compared in passing to *Macrocallista plana*, Moore, *sp.*, and even Mr. Etheridge's *Myacites, sp.*; in fact, the figure of the latter and the *Tancredia* are remarkably alike.

*Loc.* Gordon Downs (*The late R. Daintree*).

## Order—TELLINACEA.

## Family—TELLINIDÆ.

*Genus*—PALÆOMÆRA, *Stoliczka*, 1870.

(*Pal. Indica* (Cret. Fauna), 1870, iii., fasc. 1-4, p. 116.)

*PALEOMÆRA ? sp. ind.*, Pl. 26, fig. 16.

*Obs.* A very interesting shell, probably referable either to this genus, or *Tellina*, has come to light through the sinking of the Muttaborra Well. Only one valve is extant, and both the extreme ends are destroyed. The valve could only have been moderately convex, the posterior slope but little developed. On the other hand, the umbo was acute and sharp, small and incurved, whilst fine concentric lines ornamented the surface. By prolonging the concentric striæ, the length, when perfect, would be about an inch and a-quarter.

The present shell to some extent resembles a *Psammobia*, although not of the typical form. It also reminds one of *Tellina æqualis*, Gabb.,\* of the Californian Cretaceous Beds.

*Loc.* Bore at Muttaborra (*J. B. Henderson*).

*Genus*—GLYCIMERIS (*Klein*), *Lamarck*, 1799.

*Glycimeris* (*Klein*), *Lamarck*, Mem. Soc. Hist. Nat. Paris, 1799, p. 83 [*non* *Lamarck*, 1801, Syst. Anim. sans Vertéb., p. 126 = *Cyrtodaria*, *Daudin*].

*Panopæa*, *Ménard de la Groye*, Ann. Museum Hist. Nat. Paris, 1807, ix., p. 135.

*Obs.* Observations on this genus will be found under the head of "Desert Sandstone," to which the reader is referred.

GLYCIMERIS RUGOSA, *Moore, sp.*, Pl. 28, figs. 4 and 5, ? fig. 6.

*Panopæa rugosa*, *Moore*, Quart. Journ. Geol. Soc., 1870, xxvi., p. 253, t. 13, f. 7.

*Myacites ? australis*, *Hudleston*, Geol. Mag., 1884, i., p. 340, t. 11, f. 9.

*Sp. Char.* Shell transversely ovate, anteriorly inflated, very convex or gibbous in the umbonal or visceral region. Dorsal margin straight (with a raised ridge for ligamentary attachment, *Moore*); ventral margin rounded at the ends, almost straight in the centre. Anterior end closed, somewhat produced, with a sub-truncate margin and an anterior slope rather angulated from the umbones forward; posterior end rounded, more or less gaping along the posterior dorsal margin. Umbones incurved, acute (*Moore*), depressed or flattened from above. Pallial sinus very deep and moderately wide; anterior muscular impressions faint, posterior well marked. Surface with irregular, rough, concentric rugæ, stronger on the anterior end, with an epidermal covering of anastomosing fibres.

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\* *Pal. California*, 1869, ii., p. 182, t. 29, f. 73.

*Obs.* *G. rugosa* is a very wide-spread and typical shell, as not only does it occur at several localities in Queensland, but I have it in Prof. Tate's South Australian Collection. Moore's figure is most unsatisfactory, and generally unlike the shell, but possessing specimens from the typical locality, and not having seen any other shell so nearly corresponding with his species, I believe the determination to be correct. The hinge structure has not been satisfactorily made out, while it seems to be a shorter and broader form than Moore's *Mya Maccoyi*, although the latter is not definitely known to me.

*Glycimeris rugosa* seems to be distinguished from *G. sulcata*, Etheridge, by its more robust habit and the less rugged condition of the concentric undulations. One of the most striking features of *G. rugosa* is its anterior inflation, but I think the anterior margins are closed, in which case the species departs somewhat from the generic diagnosis of *Glycimeris*, Klein (*Panopæa*, Ménard). The concentric undulations on the umbones are particularly regular and close.

Prof. T. W. E. David has collected an internal cast at Maryborough,\* which appears to be too large a shell for *G. sulcata*, Etheridge, and may indicate the presence of the present species at that locality.

A striking resemblance exists between this species and Mr. Hudleston's *Myacites? australis*, which, it is almost needless to say, has no relation to typical species of that genus. There are the same prominent umbones, square anterior end, and rather attenuated posterior end, and when seen in a side view the likeness is very marked. It must be admitted, however, that *G. rugosa* has a more generally solid appearance, and is a broader shell across the valves. Although *Myacites? australis* cannot be described as a compressed form, still its girth is less in proportion to size than in the present species. Notwithstanding these differences, I do not think that the one can be regarded as more than a compressed variety of the other.

Mr. Hudleston drew attention to the general resemblance of his species to the shells figured by Mr. Etheridge as *Panopæa sulcata*, but, although generically allied, there is no specific relation.

*Loc. and Horizon.* Bungeworgorai Creek, near Mount Abundance (*The late Rev. W. B. Clarke*); Maranoa River, half a mile above Mitchell Railway Station, Pl. 28, figs. 4 and 5 (*R. L. Jack*); Maranoa River and Wollumbilla (*G. Sweet*—Colln. Sweet, Melbourne).

*Myacites? australis* was obtained in the Peak District, South Australia, and forty-five miles south-west of Cootanook Station, Lake Eyre (*H. Y. L. Brown*—Nat. His. Mus., London).

? Occurs also in the Maryborough Beds (Desert Sandstone) (*T. W. E. David*—Colln. David, Sydney).

#### GLYCIMERIS ARAMACENSIS, *sp. nov.*, Pl. 28, figs. 7 and 8.

*Sp. Char.* Shell small, transversely elongated and a little oblique, gaping at both ends, somewhat compressed. Anterior end small, the margin rounded; posterior end slightly attenuated, the margin apparently rounded, and to some extent truncate; ventral margin sharp and nearly straight. Umbones much incurved, obtusely flattened from above; posterior slopes small, flattened; diagonal ridges acute, especially towards the umbones. Anterior slopes very short and wider than the posterior; shell probably thin. Surface with coarse, large, and almost rugged concentric undulations, fourteen to

\* Maryborough Beds—Desert Sandstone.

fifteen in number, smaller and more numerous on the umbones, gradually widening out on the body of the shell, and very widely separated on the posterior ends; between the undulations are delicate striæ.

*Obs.* The coarseness of the concentric undulations brings this shell in close relationship with *Glycimeris sulcata*, Eth., but it is much longer in proportion to its height than that species, with a longer anterior end, and a straighter hinge.

*Loc.* Aramac (*R. L. Jack*).

#### GLYCIMERIS ? MACCOYI, Moore, sp.

*Mya Maccoyi*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 253, t. 13, f. 8.

*Sp. Char.* Shell ovately oblong, moderately large, tumid, inequivalve; umbones anterior, incurved, close; anterior margin truncated, angular; posterior end attenuated, rounded, widely gaping; ventral margin slightly rounded; surface of the shell with wide irregular lines of growth, the outer surface of the test, where best preserved, showing it to be very wrinkled. It is three and a-quarter inches broad by two and a-quarter in height. (*Moore*.)

*Loc.* Between the Amby and Maranoa Rivers (*The late Rev. W. B. Clarke*).

#### Family—ANATINIDÆ.

##### Genus—GONIOMYA, L. Agassiz, 1842.

(*Études critiques Moll. Foss.* 2e Livr., p. 1.)

##### GONIOMYA DEPRESSA, Moore, Pl. 28, fig. 9.

*Goniomya depressa*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 251, t. 13, f. 6.

*Sp. Char.* Shell ovately elongated, thin, flattened; umbones close, depressed, mesial; anterior end rounded; the middle of the valves with a depression or fold from the umbo, which widens to the ventral margin, surface with broad curved rounded costæ. (*Moore*.)

*Obs.* The posterior end of this figure, copied from Mr. Moore's illustration (Pl. 28, fig. 9) is wanting.

The genus *Goniomya* made its first appearance in the Lias, but did not survive the Cretaceous Period.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

##### Genus—HOMOMYA, Agassiz, 1842.

(*Études critiques Moll. Foss.*, 3e Livr. p. 154.)

##### HOMOMYA, sp. ind.

*Homomya*, sp., Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 347, t. 25, f. 5.

*Obs.* Two specimens of this genus, in a micaceous sandy or arenaceo-calcareous limestone, were examined by Mr. R. Etheridge, F.R.S., who remarked—"The absence of radiating costæ, and the somewhat wrinkled surface of the shell, as well as the position of the umbo and the gently curved hinge-line, favour the view that the two casts belong to the genus *Homomya*."

*Loc.* Gordon Downs (*The late R. Daintree*).

Genus—*CORIMYA*, L. Agassiz, 1842.

(Études critiques Moll. Foss., 3e Livr., p. 262.)

*CORIMYA WILSONI*, Moore, sp., Pl. 28, figs. 10 and 11.

*Thracia Wilsoni*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 254, t. 14, f. 8.

*Sp. Char.* Shell transversely ovate, thin, compressed, especially towards the posterior ventral margin, slightly inequivalve. Hinge-line slightly concave anteriorly, and the same, or horizontal, on the posterior; ventral margin rounded; internally the upper of the posterior ribs is placed close under the hinge-line, and almost parallel to it, but the lower bounds the posterior slope, and is oblique. Anterior side shorter than the posterior; the latter is somewhat produced, and sub-truncate; posterior slope slight; diagonal ridge rounded and inconspicuous. Umbones nearly median, but nearer the anterior end. Surface with concentric growth-laminæ and striæ, all becoming stronger on the posterior end.

*Obs.* The shell represented in Pl. 28, fig. 10, is Mr. Moore's type, and this figure, of the natural size, may be taken as a sample of the unreliable nature of his illustrations of the Queensland fossils generally. It is preserved in the Museum of the Literary and Philosophical Society of Bath, and I am indebted for the loan of it to the kindness of the Committee of that Institution through the Rev. H. H. Winwood, M.A.

This fossil has the shell preserved, but in fig. 11 of the same plate is what I believe to be the internal cast of another species. The two grooves under the posterior hinge naturally represent shelly ribs on the interior of the valve, and correspond to the structure of Agassiz's *Corimya*, especially as there is no trace of hinge teeth, or other features, which would invalidate the reference, such, for instance, as the cartilage pit of *Anatina*. It is probably Mr. Hudleston's *Thracia primula*,\* from South Australia.

Mr. Moore mentions the existence of an external ligament, and describes the valves as unequal, through the presence of "a slight sinus towards the centre of the ventral margin, with a corresponding elevation on the opposite valve." The possession of a ligament by this species would support Stoliczka's view that *Corimya* was furnished with such a mechanism. The inequality of the valves I have not seen.

*Loc. and Horizon.* Amby River and Bungeworgorai Creek (*The late Rev. W. B. Clarke*); Mimni, near Roma (*R. L. Jack*).

#### Family—MACTRIDÆ.

Genus—*MAOTRA* (Linn.), Lamarck, 1799.

(Mém. Soc. Hist. Nat. Paris, 1799, p. 85.)

*MAOTRA TRIGONALIS*, Moore, Pl. 27, fig. 17.

*Maotra trigonalis*, Moore, Quart. Journ. Geol. Soc., 1872, xxvi., p. 252, t. 14, f. 6.

*Sp. Char.* Shell small, thin, trigonal; umbones rather anterior; anterior end rounded and rather angular; front margin rounded; the surface is marked by faint transverse lines. (*Moore.*)

*Loc.* Nive River Downs (*The late Rev. W. B. Clarke*).

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\* Geol. Mag., 1890, vii. (3), p. 245, t. 9, f. 7.

## Order—PHOLADACEA.

## Family—GASTROCHÆNIDÆ.

Genus—*GASTROCHÆNA*, Spengler, 1783.

*Gastrochæna*, Spengler (Lamarck *partim*), Saml. Kongl. Danks. Vid. Selsk. Skr., ii., p. 174.  
*Chæna*, Phillipson in Retzius, Dissertatio Hist. Nat., 1788, p. 19.

*GASTROCHÆNA AUSTRALIS*, *sp. nov.*, Pl. 31, figs. 6-8.

*Sp. Char.* Valves unknown. Tube tapering but little in the fragment preserved, section nearly round. Surface covered with very fine anastomosing lines, which are the broken off, or rubbed down edges of a series of shelly frills, forming by their anastomosis transversely elongated spaces.

*Obs.* This object for a long time defied determination, but I believe the shell structure of the living *Gastrochæna grandis*, Desh., will explain its nature.

In the tube of the recent species the structure of the outer layer is vesicular, arising from the mechanical union of frilled surfaces with particles of sand. If this vesicular structure be broken, or worn-down, a series of anastomosing frills or ridges are formed, enclosing vesicles or chambers, usually transversely elongated. Supposing these to be still further denuded, the resulting structure would be a series of anastomosing lines on the fossil, instead of frills. Such is, I believe, the origin of those seen on the specimen now under description.

A species has been described from the Cretaceous rocks of India, but it is quite different from the above.

*Loc.* Maranoa River, half a mile above Mitchell River Station (*R. L. Jack*).

## PELECYPODÆ INCERTÆ SEDIS.

*Obs.* Under this heading are placed a few bivalves which it has been found impossible to relegate to their proper genera. They are figured, or refigured, as the case may be, in the hope that attention may be called to them, and additional examples obtained for further elucidation.

PL. 21, FIG. 15.—A somewhat rectangular valve, with the umbo quite at the anterior end, a nearly straight cardinal margin, and but little convex surface, which is marked with a few concentric laminæ. The posterior margin appears to be slightly emarginate. Under it is another individual, which may be the opposite valve of the same species, bearing six rib-like costæ, and shorter intermediate ones.

*Loc.* Aramac (*R. L. Jack*).

PL. 21, FIG. 16.—A nearly flat meleagriniform valve without any anterior ears, an inconspicuous umbo, short cardinal margin, slightly emarginate posterior margin, and indistinct concentric lines. This bears a striking resemblance to left valves of Whitfield's genus *Meleagrinella*,\* and which it may even represent, but I have not seen any corresponding right valves possessing the peculiarities of that genus. It is like *M. abrupta*, Conrad, sp.†, and to some extent *M. curta*, Hall, sp.‡. Some resemblance is also borne by our shell to the Indian Cretaceous species *Pseudomonotis inops*, Stoliczka.

*Loc.* Aramac (*R. L. Jack*).

PL. 21, FIG. 14.—A bivalve of a somewhat similar type to the above, but too indistinct and imperfect to have much stress laid upon it. The umbo is much more median, and the ornament is concentric.

*Loc.* Coreena Woolshed (*R. L. Jack*).

\* Mon: U. S. Geol. Survey (Powell's), 1885, ix., p. 71.

† Whitfield, *loc. cit.*, t. 14, f. 11.

‡ U. S. Geol. Survey Rocky Mt. Region (Powell's), Whitfield's Pal. Black Hills of Dakota, p. 354, t. 3, f. 20.

Pl. 24, FIG. 1.—In this figure is represented a much compressed right valve of a *Maccoyella*-like bivalve. There are no traces of radiating costæ, but in their place strong concentric lines and laminae. The dorsal margin was clearly straight, the anterior end much cut out and projecting ventrally, the ventral margin very regularly rounded, and the beak small and depressed. The shell structure is that of *Maccoyella*.

Loc. Flinders River, three miles above Richmond Downs Station (*R. L. Jack*).

Pl. 26, FIG. 13-15.\*—It has been found impossible so far to identify the genus of this shell, notwithstanding that it has been very carefully considered both by Prof. R. Tate, Mr. J. Brazier, and myself, owing to our want of knowledge of the pallial line and the hinge-structure of the right valve. The shell is obliquely trigonal, tumid in the umbonal region, the posterior end small and rather acuminate. The hinge or cardinal margin is strongly angulated, descending rapidly on the posterior side, but less so on the anterior. The ventral and anterior margins are rounded; body of the shell gibbous, and somewhat inflated, with well incurved umbones. The shell possesses an inconspicuous and not well defined lunule, and there is no defined siphonal ridge. The ligament was external. The dental characters, so far as known, in the left valve are very marked, consisting of a large projecting somewhat triangular cardinal tooth with a deep socket immediately on its posterior side, and an elongated lateral tooth. It may be a *Unicardium*. The only shell described by Moore which could have any relation to this species is his *Astarte wollumbillænsis*, but the figure being only a partial one is quite useless for comparison.

Loc. Upper Flinders River (*Hon. A. C. Gregory*).

Pl. 26, FIGS. 11 and 12.—A cytheriform shell, the valves united and much decorticated, several layers having flaked off. The hinge is not visible, but there appears to have been a lunule and an escutcheon. The outline of the valves would indicate a genus near *Cytherea* or one of its allies. There is some resemblance to *Cytherea* (?) *Hudlestoni* (Pl. 28, fig. 12).

Loc. Evora Station, twenty-five miles north-east of Blackall (*R. Morrisby*).

## Class—GASTEROPODA.

### Order—SOLENOCHONCHÆ.

#### Family—DENTALIIDÆ.

Genus—*DENTALIUM*, *Linnaeus*, 1740.

(Syst. Nat., Ed. 2, p. 61.)

*DENTALIUM WOLLUMBILLÆNSIS*, *sp. nov.*

*Dentalium lineatum*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., 2, p. 256 (*non*. Guéranger).

*Sp. Char.* Shell tubular, rather thin, tapering and slightly curved. (*Moore*.)

*Obs.* Three specimens were observed by Mr. Moore in his Queensland series of fossils. According to Stoliczka,† the name *D. lineatum* was preoccupied at the time Mr. Moore wrote by Guéranger, whose species appears to be a good one. I have, therefore, altered the name of the Australian shell as above.

Prof. R. Tate refers ‡ Moore's species to *Dentalium arcotinum*, Forbes, but I have not observed the same amount of curvature in the Australian shell as exists in the Indian. Our species is also shining and smooth.

Loc. Wollumbilla (*The late Rev. W. B. Clarke*); Glanmire Block, seventeen miles south-west of Tambo (*Mr. Goffage*).

\* See also p. 39 (*Unicardium Meeki*).

† Pal. Indica (Cret. Fauna), 1868, ii., Pts. 7-10, p. 443.

‡ Proc. Austr. Assoc. Adv. Sci. for 1888 [1889], i., p. 230.

## Order—TECHTIBRANCHIATA.

## Family—TORNATELLIDÆ.

Genus—*CINULLA*, Gray, 1840.

(Synop. Brit. Mus., 1840.)\*

*CINULLA* HOCHSTETTERI, Moore, sp.*Actæon Hochstetteri*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 256, t. 10, f. 19.

*Sp. Char.* Shell rather small, ovate; whorls five; spire rather elevated, acute; whorls covered by close, distinct, encircling transverse striæ, about thirty in number on the body-whorl, which is rather convex; aperture not exposed. (*Moore.*)

*Obs.* In general appearance this shell is not unlike *Actæon pullus*, Lycett, but the striæ with which it is ornamented are much more numerous. It was named by Mr. Moore in honour of Dr. F. von. Hochstetter, Author of the Geological Narrative of the Voyage of the Austrian Frigate "Novarra."

I am indebted to Prof. R. Tate for suggesting the reference of this species to *Cinulia* rather than *Actæon*, on account of the thickened outer lip and strong columella fold.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

Genus—*ACTÆON*, De Montfort, 1810.

(Conch. Systématique, ii., p. 315.)

*ACTÆON* DEPRESSUS, Moore, Pl. 29, fig. 9.*Actæon depressus*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 256, t. 10, f. 20.

*Sp. Char.* Shell small, conical; spire with five volutions, rather depressed; body-whorl with about fifteen rather distinct striæ; aperture ovate. (*Moore.*)

Although this shell is not in good condition, it is clearly separable from *Actæon* [*Cinulia*] *Hochstetteri* by its more depressed figure, and by the difference in the external striæ. (*Moore.*)

Mr. Hudleston's figure of *Actæon* or *Avellana*, sp.,† from South Australia, is probably a better representation of the present species than either Moore's illustration or that given here.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*); North-east end of Glanmire Block, seventeen miles south-west of Tambo (*Mr. Goffage*).

## Order—SCUTIBRANCHIATA.

## Family—PLEUROTOMARIIDÆ.

Genus—*PLEUROTOMARIA*, DeFrance, 1824.

(Tableau Corps Organ. Foss., p. 114.)

*PLEUROTOMARIA* ? CLIFTONI, Etheridge, Pl. 29, fig. 10.*Pleurotomaria Cliftoni*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 347, t. 25, f. 4.

*Sp. Char.* Shell trochiform, spire elevated, apex acute, whorls four to five, rapidly increasing, body-whorl large; aperture large and nearly round, base convex; columella thick, umbilicus apparently wanting or very small. (*Etheridge.*)

\* *Fide* Agassiz, Nomen. Zool. (Gen. Moll.), p. 19.† *Geol. Mag.*, 1890, vii. (3), p. 243, t. 9, f. 4.



*Obs.* The body-whorl is more than double the dimensions of the preceding or fourth whorl, and proportionally much more globose, and crossed diagonally by delicate lines of growth at an angle of  $45^{\circ}$ . The rather broad sinus occupies the upper half of the body-whorl. I find great difficulty in referring this shell specifically to any known British form. It, however, resembles *Turbo* (*Pleurotomaria*) *Dunkeri*, Goldf., from the Middle Lias. (*Etheridge*.)

The resemblance of this species to a typical *Pleurotomaria* is not a marked one; in fact, it is very much more like those Palæozoic shells called *Murchisonia*, with rounded whorls. Nor does the word "trochiform" strictly describe its shape; it might be better described as conically or elongately turbate.

*Loc.* Gordon Downs, near Roma (*The late R. Daintree*).

### Family—TROCHIDÆ.

*Genus*—*DELPHINULA*, Lamarck, 1804.

(Ann. Mus. Hist. Nat. Paris, iv., p. 108.)

*DELPHINULA* ? *REFLECTA*, Moore, Pl. 29, fig. 12.

*Delphinula reflecta*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 256, t. 10, f. 21.

*Sp. Char.* Shell rather small, turbinated; whorls 3-4; spire slightly elevated; volutions separated by an encircling sinus; body-whorl much increased; aperture circular, with a thick reflected lip. (*Moore*.)

*Obs.* The present species is either a very aberrant form of *Delphinula*, or it cannot be referred to that genus, for it is hardly necessary to observe that neither the inner nor the outer lip of *Delphinula* is reflected, in the proper sense of the word.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

### Order—PECTINIBRANCHIATA.

#### Family—NATICIDÆ.

*Genus*—*NATICA*, Adanson, 1757.

(Hist. Nat. Sénégal, Coquil., p. 172.)

*NATICA* *VARIABILIS*, Moore, Pl. 31, figs. 2 and 3.

*Natica variabilis*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 256, t. 10, f. 15.

„ *lineata*, Etheridge, *Ibid.*, 1872, xxviii., p. 342, t. 21, f. 1.

„ *sp.*, Hudleston, Geol. Mag., 1884, i., p. 339, t. 11, f. 4.

*Sp. Char.* Shell very thick, broader than high; spire of 3-4 volutions, somewhat depressed; body-whorl increasing rapidly in size and extended; aperture ovate; umbilicus small. (*Moore*.)

*Obs.* This species is abundant, and I have had an opportunity of examining specimens in various conditions. When the body of the shell has been worn, it presents a rugosely striated surface; but in smaller examples, in which the shell is usually better preserved, the test is seen to have a comparatively smooth striated exterior. (*Moore*.)

It closely resembles *N. gaultina*, from the Gault of Folkestone and the Greensand of Blackdown.

The suggestion thrown out by Mr. Etheridge, that his species is probably identical with Moore's previously described one, has been adopted by Prof. R. Tate,\* who has united them. It is the same as Mr. Hudleston's unnamed shell. *Natica*

\* Trans. R. Soc. S. Australia, 1885, vii., p. 75; Proc. Austr. Assoc. Adv. Sci. for 1888 [1889], i., p. 130.

*variabilis* appears to have a wide geographical distribution, for it is one of the shells obtained by Mr. Chandler\* in the neighbourhood of the Peake, Central Australia.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*); Marahoa River, at Mitchell, and Blyth Creek, near Blythsedale Station (*G. Sweet*—Colln. Sweet, Melbourne).

*NATICA ORNATISSIMA*, *Moore*, Pl. 25, fig. 11.

*Natica ornatissima*, *Moore*, Quart. Journ. Geol. Soc., 1870, p. 257, t. 10, f. 16.

*Sp. Char.* Shell small, spire depressed; whorls convex, the last very rounded and globose; aperture large and circular. (*Moore*.)

Shell-structure smooth, with broad bands of growth at intervals, within or on the surface of which are finer striations. The shell still retains some of its original colour. (*Moore*.)

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

*NATICA JACKII*, *sp. nov.*, Pl. 21, fig. 22.

*Sp. Char.* Shell ovate, sub-globose, of about four whorls; spire short; upper volutions very short, convex, separated by a moderately marked suture; mouth ovate, nearly straight along the inner lip; the latter is but little reflected or thickened; umbilicus moderately large; surface of the body-whorl bearing strong, sub-imbricating, oblique, transverse rugæ (which are also faintly perceptible on the penultimate whorl), crossed on the lower portion of the whorl by oppositely directed, oblique, semi-spiral rugæ of different lengths, wider apart than the transverse ridges, and to some extent effacing them, and producing a more or less V-shaped ornament.

*Obs.* This peculiar and handsomely sculptured little shell may perhaps be referable to *Vanikoro* (*Narica*, Recluz), or even *Vanikoropsis*, Meek, but I am not yet satisfied how far the sculpture is persistent. The spiral lines start from the inner lip, passing obliquely round the whorl to the outer lip, but during their course are faulted downwards, as the width of the whorl increases.

I have been unable to find any described species of *Natica* bearing similar sculpture, even with the assistance of my former Colleague, Mr. Edgar A. Smith. A recent form, *Natica cancellata*, Lamk., from the Isle of Nevis, is wholly cancellated, and so is a fossil *Neritina*, described by D'Orbigny,† from the Cretaceous rocks of South America, in which the spiral striæ are confined to a zone all round the body-whorl. The absence of a callosity on the inner lip, irrespective of other features, separates *Natica Jackii* from both the foregoing.

In this species the inner lip can hardly be said to be reflected, and there existed a well-marked and elongated umbilical opening.

*Loc.* Cloncurry Road, at Julia Creek (*R. L. Jack*).

Family—STROMBIDÆ.

*Genus*—*ANCHURA*, *Conrad*, 1860.

(Journ. Acad. Nat. Sci. Philadel., 1860, iv., p. 284.)

*ANCHURA*? *WILKINSONI*, *sp. nov.*, Pl. 31, figs. 4 and 5.

(Compare *Alaria* or *Anchura*, *sp.*, *Hudleston*, Geol. Mag., 1890, vii. (3), p. 242, t. 9, f. 2.)

*Sp. Char.* Shell (without the expanded lip) fusiform, of six or more whorls, angulated in the middle line, the last unequally biangular; last whorl abruptly contracted into the base of the beak below; aperture (?) rhombic oval; the median angular

\* Trans. R. Soc. S. Australia for 1880-81 [1882], iv., p. 149.

† *N. divaricata*, D'Umont d'Urville's Voy. Pole Sud. Géologie, 1847, Atlas, t. 7, f. 43 and 44.

line of all but the last whorl occupied by small, semi-separate nodes; carina of the last whorl without any apparent upward flexure, but below it is a second and finer sub-parallel keel, which diverges somewhat downwards; general surface covered with revolving striæ.

*Obs.* The outer lip, with its digitation or digitations, is unknown, and the inner lip not preserved. Through the non-preservation of these portions and the canal, it is difficult to accurately determine the genus to which this shell should be referred. It may be either *Aporrhais*, *Anchura*, or *Drepanochilus*; but from the divergence of the revolving carinæ on the last whorl, and thereby probably indicating two digitations of the outer lip, one of the two former is the most likely. In their present condition our specimens are not unlike *Dicroloma*, Gabb.; but the species may for the present be referred to *Anchura* provisionally.

It is possible that the "*Alaria* or *Anchura*" figured\* by Mr. Hudleston from South Australia is a different species from *A. ? Wilkinsoni*. The latter is named in honour of the late Mr. C. S. Wilkinson, Government Geologist of New South Wales.

*Loc.* Evora Station, twenty-five miles north-east of Blackall (*Rowland Morrisby*).

### Class—CEPHALOPODA.

### Order—DIBRANCHIATA.

### Family—LOLIGINIDÆ.

*Genus*—*TEUTHIS*, *Schneider*, 1784.

(Sammlung verm. Abhandl., p. 113.)

*Obs.* Small portions of the shaft of a pen (Pl. 35, fig. 21), with the lateral expansion of the wings, indicate the presence of a Cephalopod allied to the Calamaries. The remains are all fragmentary. (*Moore*.)

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

### Family—BELEMNITIDÆ.

*Genus*—*BELEMNITES* (*G. Agricola*), *D'Orbigny*, 1840.

(Pal. Franç. Terr. Crét., 1840, i., p. 37.)

*BELEMNITES AUSTRALIS*, *Phillips*, Pl. 35, figs. 1 and 2.

*Belemnites australis*, Phillips in Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 258, t. 16, f. 1 and 2.

*Sp. Char.* Guard hastate, depressed in the postalveolar region by lateral expansion; ventral face somewhat flattened, but without trace of a ventral groove; two lateral grooves sharply cut, and approximating to the ventral face in the alveolar region, thence bending toward the dorsal aspect, and continued in a fine stria on the middle of the side. Length four and a-half inches to the point where the guard grows, thin over the phragmacone; diameters at the alveolar apex 0.725 and 0.600, further back in the more flattened part 0.770 and 0.600. Axis of the guard 3.300. Proportion of axis to ventro-dorsal diameter as 550 to 100, of ventral to dorsal radius as 40 to 60. Phragmacone unknown, its angle 20°. (*Phillips*.)

*Obs.* A much older specimen is a split half, the fissure being dorso-ventral. It shows the lateral groove, marked with a double stria, and the nearly straight-sided excentric alveolus. The axis of the guard is curved, and channelled, as in some specimens

\* Geol. Mag., 1890, vii. (3), p. 242, t. 9, f. 2.

from the Oxford Oolite. The ventral portion is to the dorsal as 40 to 60; the axis, as is usual in old specimens of hastate *Belemnites*, is not longer than in youth, and its proportion to the diameter is reduced to 240 : 100.

These fossils appear, on the whole, most allied to *Belemnites hastatus*, Blainville, and to the depressed variety of it which occurs in the Oxford Clay of England. But they are entirely distinct by the lateral grooves being so sharply cut over the alveolar and postalveolar region, and by the absence of a ventral groove.

There is, indeed, one specimen (the posterior part of a large guard) marked "Upper Maranoa River," which, with portions of the lateral grooves, shows along the ventral face a partially impressed but interrupted groove, not unlike some appearances of *Belemnites sulcatus* of the Oxford Clay of England. The lateral grooves show ramifications, and appear not to bend backward. It may be a different but allied species. (*Phillips in Moore.*)

The *Belemnites* described \* by Sir James Hector as *B. australis*, Phill., do not appear to belong to this species at all.

*Loc.* Wollumbilla and Upper Maranoa River (*The late Rev. W. B. Clarke*).

#### BELEMNITES OXYS, *Ten. Woods.*

*Belemnites oxys*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 3, p. 237, t. 13, f. 1-3.

„ *australis*, Ten. Woods (non Phillips), *loc. cit.*, p. 236.

*Sp. Char.* Guard hastate, with a rather long, very slightly undulating outline, ventral face flattened but without a trace of a ventral groove; two lateral grooves sharply cut, and approximating to the ventral face in the alveolar region, thence bending towards the dorsal aspect with a scarcely perceptible curve and continued in a fine stria on the ventral margin. Length of preserved portion one hundred and forty-five millimetres, width of the alveolar end twenty millimetres, greatest width at the end of the lateral groove, and about the centre of the fossil twenty-two millimetres, ventro-dorsal width greatest at the broken end, and gradually tapering thence to the point. (*Ten. Woods.*)

*Obs.* *B. oxys* differs from *B. australis* in its greater length, tapering outline, and different curvature of the lateral groove. Notwithstanding that it otherwise generally resembles the latter, the outline of the two species is so markedly different as to necessitate their separation, at any rate pending the discovery of intermediate forms.

*Loc.* Mount Stewart Run, Grey Ranges, New South Wales, near the South Australian and Queensland borders.

#### BELEMNITES CREMOS, *Tate*, Pl. 35, fig. 6.

*Belemnites paxillosus* (Schlotheim), Phillips, Quart. Journ. Geol. Soc., 1870, xxvi., p. 240, t. 16, f. 6a and b.

„ *cremos*, Tate (ms.), Proc. Austr. Assoc. Adv. Sci. for 1888 [1889], i., p. 229.

*Obs.* Up to a comparatively recent date the only evidence of this *Belemnite* as an Australian species was the following quotation from Mr. Moore's Memoir. He states that two imperfect specimens were obtained from a Wollumbilla block and submitted to the late Prof. John Phillips, who stated that "they belong to young *Belemnites* and show the phragmacone *in situ*, and the straight nearly central axis of the guard with a small canal. The cross-section of the phragmacone is distinctly elliptical and oblong; the siphuncle is clearly enclosed; longitudinal dorsal striæ very distinct. I have made a sketch of these points, which on the whole make me adhere to the opinion of the Oolitic, and perhaps Liassic, affinity of this shell. It appears to be most nearly allied to *B. paxillosus*, but to be distinct by its elliptical phragmacone; this ellipticity diminishes with age."

\* Trans. N. Zealand Inst., 1878, x., p. 487, t. 23, f. a-c.

More recently, however, Prof. R. Tate has proposed\* for this Belemnite the above name, and believes that the oblique lateral furrows, and the absence of apical furrows, place it near *B. australis*, Phill.

*Loc.* Wollumbilla (*The late Rev. W. B. Clarke*).

**BELEMNITES SELLHEIMI, Ten. Woods, Pl. 35, figs. 10 and 11.**

*Belemnites Sellheimi*, Ten. Woods, Journ. R. Soc. N. S. Wales for 1882 [1883], xvi., p. 150, t. 7, f. 1.

*Sp. Char.* Phragmacone extending at an angle of  $17^{\circ}$ , circular, broken at each end; 100 mm. long, 45 mm. at broad end, and 15 mm. at narrow end; chambers twenty-five in number, slightly oblique, advancing a little on the dorsal face, and retiring on the ventral, with slight lateral flexure; an obscure carina on the dorsal face, with a distinct shallow groove for the whole length. (*Ten. Woods.*)

*Obs.* Although a portion of a phragmacone is hardly the material on which to establish a species, this name will suffice to distinguish that part of an undoubtedly large Belemnite which occurs in the "Rolling Downs Formation."

It is very probable, as stated by Mr. Woods, that *B. Sellheimi* corresponds to a large phragmacone of doubtful affinity described by Prof. Phillips, from Wollumbilla,† and may be identical with it. He says—"Phragmacone 5.5 inches long, its greatest diameter 1.75, the section nearly circular. Above forty septa can be counted; and the whole number must have been fifty, without reaching the last chamber. The septa are a little oblique, advancing in the dorsal and retiring a little on the ventral face, with a slight lateral flexure. Depth of the chambers about one-sixth of the diameter. Siphuncle clearly internal, its section rather elliptical. The phragmacone is nearly straight, with an angle of  $18^{\circ}$ ."

Many years ago the late Rev. W. B. Clarke ‡ named a Belemnite from the same locality as *B. Barklyi*, but all that is known of this is a remark by Prof. F. McCoy,§ "A large species . . . nearly related to the gigantic species of the Lower Oolite and Lias of Europe, but which cannot be fully characterised from the present specimen, as all the posterior portion of the guard is broken away." Possibly this may be Mr. Wood's species also.

My Colleague's Collection contains a portion of a phragmacone consisting of five chambers, not far removed from the proximal end, one and a-quarter inches in diameter, and each about three-eighths of an inch deep (Pl. 35, figs. 10 and 11). The length is one inch, and the siphon small and quite internal. The fragment, so far as preserved, is rather straight-walled, with an ill-defined dorsal carina and a faint groove. The septa advance on the dorsal side and retreat on the ventral, and laterally have a slight flexure. In a great measure agrees with Phillips' phragmacone above described, but is still more in accord with Woods' *B. Sellheimi*.

In the Queensland Museum is a still more perfect phragmacone five inches in length with a proximal diameter of two inches, and a distal of three-quarters of an inch without having attained the terminal chamber. There are portions of about twenty-six chambers preserved.

*Loc.* Palmer River (*P. F. Sellheim*); Wollumbilla (*The late Rev. W. B. Clarke*); Flinders River, near Hughenden (*Rev. T. W. Ramm*); Walsh River (*C. W. De Vis*—Queensland Museum, Brisbane).

\* Proc. Austr. Assoc. Adv. Sci. for 1888 [1889], i., p. 229.

† Quart. Journ. Geol. Soc., 1870, xxvi., p. 258.

‡ *Ibid.*, 1862, xviii., p. 246.

§ Trans. R. Soc. Vict., 1865, vi., p. 43.

## BELEMNITES CANHAM, Tate.

Pl. 35, figs. 3-5, 7-9, 12-14; ? Pl. 39, figs. 6 and 7.

*Belemnitella diptycha*, McCoy (ms.), Ann. and Mag. Nat. Hist., 1867, xix., p. 356; *Ibid.*, 1867, xx., p. 196.

" " " " Trans. R. Soc. Vict., 1868, viii., Pt. i, p. 42.

*Belemnites Canhami*, Tate, Proc. R. Soc. S. Austr. for 1879-80 [1880], p. 104, t. 4, f. 2a-2c.

*Sp. Char.* Guard hastate terminating in an acute sub-mucronate, central point, contracted in the medio-alveolar region, compressed ventro-dorsally, the ratio of the two diameters measured at a little further back than at the alveolar apex is as two to three. Each dorso-lateral face presents, through the whole length of the alveolar region, a deep and sharply cut furrow; in the region of the alveolar apex it makes an abrupt turn on to the medial line of the side of the guard, then splits into two shallow grooves, separated by a uniform distance about equal to their own width, which are continued to the apex. Phragmacone sub-oblong in its transverse section; the dorso-ventral diameter is to the other in the proportion of eleven to thirteen; siphuncle sub-internal, and the axis of the phragmocone is nearly straight. Length of the guard four inches; greatest diameter is nine-tenths, and the corresponding shortest diameter is six-tenths of an inch; axis of guard two and a-half inches. (Tate.)

*Obs.* This species differs from *B. australis*, Phill., "in being more distinctly hastate, much more compressed, and in the lateral grooves being continued into a double sulcus." I believe Professor Tate is right in separating from the original figures of *B. australis*, Phill., two and placing them with the present species. The community of form mentioned by Tate is traceable through several specimens examined by me, notwithstanding the fact that the lateral grooves are not always well preserved. Thus, in Pl. 35, figs. 7 and 8, they are faintly visible, through the surface being much worn, but in fig. 9 of the same plate they are not to be seen at all.

The specimens before me have yielded the following characters:—The guard is sometimes subspathulate or fusiform, but not greatly flattened, almost circular near the distal termination of the alveolar region; thence gradually swelling out, with an elliptical section, and slowly acuminate to the posterior end, which is pointed, or mucronate, but without an extended mucro. The dorso-lateral grooves at their proximal ends are wide and deep, rather far apart, and give to the section quite a pinched-in appearance. The axis of the guard is decidedly excentric, and there seem to be two vascular grooves on each side, but on this point I am not quite satisfied.

For some years now, lists and general notices of Australian Mesozoic fossils, including references of my own, have contained the name of *Belemnitella diptycha*, McCoy. The meagre remarks made by Sir F. McCoy on this Belemnite make it very difficult to recognise the species; but his comparison with *Belemnitella plena*, of the European Chalk, renders it much more easy of accomplishment. *B. diptycha* is said to differ from *B. plena* by being larger, the dorsal furrows a little farther apart, and the absence of a ventral furrow. I had provisionally named the specimens, Pl. 35, figs. 7-9, *Belemnitella diptycha*, McCoy, but was always much perplexed by the absence of the ventral groove on which the generic separation between *Belemnites* and *Belemnitella* is chiefly based. I have recently been favoured by Sir F. McCoy with the specimen on which he based the name, and to my surprise found it to be only a fragment of the distal end of a guard, indistinguishable from Tate's *Belemnites Canhami*. Under these circumstances, the one must be considered as a synonym of the other, and taking into consideration the excellent description of Professor Tate, accompanied by a comprehensive figure, we cannot do less than accept his name, in preference to the hardly diagnosed species of McCoy.

It cannot be denied that in general appearance *Belemnites Canhami* greatly resembles *Belemnitella plena*, especially those figures given by D'Orbigny under the name of *Belemnitella vera*,\* but, of course, so far as we know them, the difference is a generic one.

*Loc.* Cambridge Downs Run, Flinders River, six miles from Richmond Downs Station (*Mr. Sanders*); Aramac Well, at two hundred and thirty-eight feet (*S. Sharwood*); Flinders River, near Hughenden (*Rev. T. W. Ramm*); Thurloo [? Thurles], two hundred miles north-west of Bowen, at four hundred feet deep (*Dr. J. C. Cox*—Mining and Geol. Mus., Sydney); Barcardine (*The late James Smith*); Wood-duck Creek, near the Peake, Central Australia (*Messrs. J. Canham and Chandler, fide Tate*—Colln. Tate); Base of Walker's Table Mountain, Flinders River, as *Belemnitella diptycha*, McCoy (*Messrs. Carson and Sutherland, fide McCoy*—Colln. National Museum, Melbourne).

BELEMNITES? LIVERSIDGEI, *sp. nov.*, Pl. 35, figs. 17-20.

*Sp. Char.* Guard small, elongate, claviform, posteriorly extended or graduated into a mucro of greater or less length, depressed (from dorsal to ventral) but not compressed (from side to side), from three-quarters to one and a-half inches long; ventral surface bearing a groove extending for about half the guard length, and sometimes even more; axis very excentric and ventral, superficial, and shown on the surface as a light-coloured line; section oval to elliptical; lateral vascular markings double, very fine, extending the whole length of the guard.

*Obs.* I have ventured to describe this peculiar little Belemnite under the above name, believing it to be new to Australia, in honour of Professor Archibald Liversidge, F.R.S., of Sydney University, to whom I am indebted for an opportunity of examining many interesting fossils.

The shape at once reminds us of *B. minimus*, Lister, of the Gault, by the extended pipe-like posterior end, and the size. It is distinguished, however, by the marked excentricity of the axis of the guard, which in our species is only superficial. There appears to be a long ventral groove, but how far this extends it is difficult to say, as the proximity of the axis to the surface seems to have produced a line of least resistance, and sometimes gives rise to a crack.

In one example (Pl. 35, fig. 18), which may be this species, is a fine grooved line on the guard, also impressed on the phragmacone, which is partially preserved, passing through all its shelly layers. Viewed from this light, the crack above mentioned is probably in place, and represents the ventral groove, which extends the whole length of the guard.

The excentricity of the axis is well shown in some cross-sections, and in such it is seen to approach the periphery immediately below the outermost shelly layer.

Pl. 35, figs. 17, 19, and 20, seem to show a central canal along the axis line of the guard, which is made apparently by weathering. This may be related to an extension of the initial spherule, as described by the late Prof. J. Phillips, who says—"It is supposed by some writers to have been extended backward into a small canal at the meeting of the fibres along the axis of the guard," &c. The latter is very apparent in some of our specimens, and it is equally clear that it becomes a canal or tube. Fig. 19 may be explained in this way, or perhaps it may be a portion of the alveolus with the siphon remaining.

Hauer has described a species from New Zealand under the name of *B. aucklandiensis*,† which to some extent resembles our species.

\* Pal. Franç. Ter. Crét. Ceph. i., Suppl., 1847, t. 2.

† Reise Osterr. Fregatte Novara, 1857-59, Geol. Theil., Bd. i., 2 Abth., 1865, p. 29, t. 8, f. 3c.

These little Belemnites have also some resemblance to *B. hastatus*, Blainville, from the Oxford Clay; but the anterior end of our form, as in *B. minimus*, is much too short, and the ventral groove in no way corresponds to the depth and distinctness of the former. It is also quite distinct from *B. pistiliformis*, Blainville, being distinguished by its posterior mucro.

*Loc.* Aramac (*The late James Smith*).

#### BELEMNITES, *sps.*

*Obs.* In addition to the species described, sundry interesting fragments have from time to time come to light. Mr. R. Etheridge, F.R.S., referred \* to phragmacones and alveolar cavities from Belcombe Creek, Black Downs, and compared them to *B. abbreviatus* of the Oxford Clay and Coral Rag.

The late Prof. J. Phillips referred to a small species from the Upper Maranoa in the following words†:—"Here is a small nearly cylindrical Belemnite, with a sub-central axis and an acute-angled alveolar cavity. It has one long narrow groove, not clearly seen to be a ventral groove. Though incompletely exhibited, it must be a distinct species from the others. . . . It is not one of the *Canaliculati*, but more probably one of the *Hastati*."

From Blackall Road, nine miles from Tambo, my Colleague has collected several fragments, two of which are figured. In Pl. 35, fig. 15, is seen a phragmacone and portion of a guard. The former is one and a-quarter inches long, and possesses from sixteen to eighteen chambers. The entire specimen is three and three-quarter inches long.

The specimen illustrated in Pl. 35, fig. 16, differs from the preceding figure in the larger number of chambers in the phragmacone, and in their lesser depth. There are twenty-three or twenty-four chambers in the space of one inch.

### Order—TETRABRANCHIATA.

#### Family—AMMONITIDÆ.

#### *Genus*—AMMONITES, *Auctororum*.

#### Section—AMALTHEUS.

#### AMMONITES OLENE, *Ten. Woods*, Pl. 29, fig. 5; Pl. 30, fig. 4.

*Ammonites olene*, *Ten. Woods*, Journ. R. Soc. N. S. Wales for 1882 [1883], p. 150, t. 7, f. 2, t. 8, f. 1.

*Sp. Char.* Shell much compressed, periphery narrowed to an acute angle; whorls eight and a-half probably; umbilicus apparently narrow; sutures very indistinct, apparently seven, much divided, rounded lobes on each side; diameter, 103 mm., thickness 17 mm.; surface crossed by rather broad obtuse sigmoidal ribs which are rather acutely bent in the middle, some few bifurcate. (*Ten. Woods*.)

*Obs.* This Ammonite is compared by its author to *A. biflexuosus*, D'Orb.,‡ from the Great Oolite, but the keel is not so acute, otherwise there appears to be but little difference between the two species, so far as outward appearance goes. It also resembles the Cretaceous *A. cultratus*, D'Orb.,§ but the ribs are much more sigmoidal in the Australian fossil.

\* Quart. Journ. Geol. Soc., 1872, xxviii., p. 346.

† *Ibid.*, 1870, xxvi., p. 259.

‡ Pal. Franç. Terr. Jura, 1842, i., p. 422, t. 147.

§ *Ibid.*, Terr. Cret., i., p. 145, t. 46, f. 1 and 2.



I have seen an Ammonite from Primrose Springs, South Australia, collected by H. Y. L. Brown, very closely allied to, if not identical with, this species.\*

Loc. Palmer River (*The late Rev. J. E. T. Woods*).

AMMONITES WALSHENSIS, *sp. nov.*, Pl. 42, figs. 10 and 11.

*Sp. Char.* Shell discoid, thin, much compressed; whorls high, increasing very rapidly in size, the inner more or less concealed; umbilicus narrow, moderately deep, and small for the size of the shell; mouth sagittate; back exceedingly sharp and without a defined keel; flanks almost flat, having the slightest possible convexity, but immediately below the knife edge of the back slightly concave, surface with faint geniculate, or partially sigmoidal, delicate riblets, strongest around a line almost midway between the umbilicus and edge of the shell, and there producing a very slightly perceptible ridge; between the riblets at this point are a series of wrinkles which assist in producing this median line, and breaking the general continuity of the flanks; towards the periphery spiral lines are visible, but without causing any marked reticulation; sutural characters unknown.

*Obs.* In form this Ammonite resembles many Lower Mesozoic and Cretaceous forms. Its outline closely follows that of *Ammonites (Amaltheus) lymensis*, Wright,† but the ornament of the two shells is different. The spiral lines remind us of *A. (Amaltheus) margaritatus*, Mont.,‡ but the cordate keel and large open umbilicus of the latter at once separate the two species.

Amongst Cretaceous Ammonites, *A. complanatus*, Mantell, of the Grey Chalk, may be referred to. In form, but not wholly in structure, our species resembles *A. clypeiformis*, D'Orb.,§ from the Neocomian, but it is more compressed, and the former appears to be a plain shell with a moderately open umbilicus. In the small condition of this feature, and the sharp back, *A. walshensis* is brought into close contiguity with *Ammonites requienianus*, D'Orb.,|| which is very similar to the present species except for its closed and very small umbilicus.

Referring again to *A. complanatus*, Mantell,¶ notwithstanding the great similarity in shape to *A. walshensis*, including even the wrinkled median line on the flanks, there appears to be an absence of the spiral lines, and with these is the remarkable peculiarity of a pin's-point umbilicus, and a flat narrow back.

My friend, Dr. Henry Woodward, to whom a photograph of this Ammonite was sent, suggests a comparison with *Ammonites D'Orbignyanus*, Geinitz, but a figure of this shell is not accessible to me.

Loc. Walsh River (*Hann's Expedition—Queensland Mus.\*\**)

#### Section—SCHLÖNBACHIA.

AMMONITES INFLATUS, *J. Sowerby*, var., Pl. 34, figs. 1-4.

*Ammonites inflatus*, *J. Sowerby*, Min. Con., 1817, ii., p. 170, t. 175.

" " D'Orbigny, Pal. Franç. Terr. Cret., 1840, i., p. 304, t. 90.

" " Stoliczka, Pal. Ind. (Cret. Ceph.), Ser. 3, 1861, Pt. i., p. 48, tt. 27, 28, 29, and 30, f. 1-3.

*Sp. Char.* Shell discoid, sub-compressed, not greatly inflated, strongly carinate, four or five whorls visible, ovately quadrangular in section; umbilical cavity freely

\* This has lately been described by Mr. W. H. Hudleston as *A. fontinalis* (*Geol. Mag.*, 1890, vii. (3), p. 241, t. 9, f. 1).

† Mon. Lias. Ammonites, 1881, Pt. 4, t. 48, f. 1 and 2.

‡ *Ibid.*, 1882, Pt. 5, t. 53.

§ Pal. Franç. Terr. Cret., i., p. 137, t. 42, f. 1 and 2.

|| *Ibid.*, p. 93.

¶ See Sharpe, Mon. Chalk Moll., Pt. i., 1853, t. 7, f. 1a and b.

\*\* Therefore probably collected by Mr. Norman Taylor, Geologist to the Expedition.

exposing the embraced whorls; ventral surface (or back) obtusely rounded; keel prominent, erect, and rounded. In the septa the siphonal lobe is short and broad, almost plain-margined; ventral lobe rather deep; ventral saddle broad, of two chief portions, deeply divided at their sides, each being again subdivided at their apices; superior lateral lobe deep, and unequally subdivided, being tripartite; first lateral saddle short and bifurcate; inferior lateral lobe short, with two lateral and two terminal divisions; second lateral saddle resembling the first; the whole occupying about three and a-quarter ribs, pectinations strong. The transverse ornamenting costæ are tuberculated, frequently bifurcating, the division in each case taking place clear of the umbilical cavity; the largest tubercles are along the sides of the back, and are themselves transversely crenulated, whilst those around the umbilical edge are also very prominent; on the embraced whorls a single row of tubercles is visible, the intercostal surfaces are finely transversely striate.

*Obs.* A careful comparison with authenticated specimens of *Ammonites inflatus* leaves little doubt that we have in the Queensland fossils a variety very closely assimilating to the parent species; the only difference I am able to point out lies in the possession of a rather narrower back, the space between being more acute than in the type form. So much variation occurs amongst Neocomian Ammonites, especially as regards age and locality, that the foregoing points, other characters being equal, can hardly debar the Queensland shells from being placed in this species. This variation in the keel gives to the general outline a more acutely quadrangular shape. The form otherwise, ornament, and general features are particularly alike in the fossils of the two hemispheres, but the figures given by the late Dr. Stoliczka of *A. inflatus* from the Indian Ootatoor Group, even bear closer resemblance to the Australian variety than do those of the species proper from Europe.

A fragment of an Ammonite (Pl. 34, fig. 4), collected at Aramac by the late Mr. James Smith, is also probably referable to *Ammonites inflatus*, as there are traces of strong tuberculated costæ, and tubercles around the umbilical edge.

It is again possible that a small Ammonite represented in Pl. 42, fig. 12, may be this species, although the costæ are more sigmoidally bent. This is an impression on the fractured end-surface of a bore-core, and the impression is one inch in diameter. The whorls are few, and there is a forward prolongation of the ventral edge into a well-marked rostrum. The flanks bear coarse, strong, sigmoidal ridges, with here and there smaller interpolations. The form of the back is unknown. In addition to a general resemblance to *A. inflatus*, this little Ammonite recalls to mind such forms as *A. denarius*, Sby., *A. lautus*, Parkinson, and other Cretaceous species.

*Loc.* North-east end of Glanmire Block, seventeen miles south-west of Tambo (Mr. Goffage); Aramac, Pl. 34, fig. 4 (The late James Smith); Warriana Bore, at a depth of three hundred and seventy-five feet, twenty-eight miles from Hughenden, on the Winton Road (J. B. Henderson).

#### Section—HAPLOCERAS.

##### AMMONITES FLINDERSI, McCoy, Pl. 30, figs. 1-3.

- Ammonites Flindersi*, McCoy, Ann. and Mag. Nat. Hist., 1865, xvi., p. 334; *Ibid.*, 1867, xx., p. 196.  
 " " McCoy, Trans. R. Soc. Vict., 1866, vii., p. 51; *Ibid.*, 1868, viii., Pt. 1, p. 42.  
 " *Beudanti*, var. *Mitchelli*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 345, t. 23.  
 " *Flindersi*, Etheridge fil., Cat. Australian Foss., 1878, p. 115.

*Sp. Char.* Shell discoidal, compressed, composed of four or five whorls rapidly increasing and about one-fourth of the width of each exposed in an obtusely angular-edged, flat-sided umbilicus; periphery narrow, sides nearly flat, ornamented with gently

elevated undulating or sigmoidal ribs or folds bending towards the aperture, and about half an inch apart on the middle of the whorl. These and the interspaces are occupied by delicately arranged equidistant parallel lines or costæ, which pass over the back; aperture oval, back rounded and narrow, no keel; inner whorls exposed; walls of umbilical cavity angular, flat-sided, or bevelled and smooth; seven much-divided lobes in the septa of each side, two of which are within the edge of the umbilicus. (*McCoy and Etheridge*.)

*Obs.* This Ammonite, in its intermittent folds, involution of whorls, and general habit, much resembles *A. Beudanti*, D'Orb., from the Gault of England and France, to which it is certainly closely allied. This is the opinion of Mr. R. Etheridge, F.R.S.; and Sir F. McCoy's appears to have been the same, for he says: "So nearly identical with the very common *A. Beudanti* (Br.) of the French Lower Chalk, that, but for being slightly less compressed, and a slight difference in some of the septal lobes, it could scarcely be separated, even as a variety."

I have examined the type in the National Museum, Melbourne, and believe Mr. Etheridge's var. *Mitchelli* to be a synonym of Sir F. McCoy's species.

A very small and neat, smooth and discoidal Ammonite (Pl. 30, figs. 5 and 6), with nearly flat sides, has been found in the mud-stone of Aramac Well. The shell is flat, of three to four whorls, umbilicus small, the back semi-rounded, with a very delicate keel, and a thin test. With the exception of the keel this appears very like what the young of *A. Flindersi* would be. It is of the same character and proportions, but is even more like that of *A. Gardeni*, Baily,\* which has similar whorls and keel. The latter is common to the Cretaceous of both South Africa and India.

The back of the little Ammonite is too broad for *A. olene*, Woods, and there are no transverse rugæ, although they are, to some extent, of the same type.

*Loc.* Base of Walker's Table Mountain, Flinders River (*Messrs. Sutherland and Carson*—National Museum, Melbourne); Hughenden Station, Flinders River (*The late R. Daintree*; *G. Sweet*—Colln. Sweet, Melbourne); [? Barcaldine Railway Station, Central Railway (*R. Sexton*); ? Aramac Well, at two hundred and ninety feet (*S. Sharwood*)].

#### AMMONITES DAINTREEI, *Etheridge*, Pl. 29, figs. 1-3.

*Ammonites Daintreei*, *Etheridge*, Quart. Journ. Geol. Soc., 1872, xxviii., p. 346, t. 24.

*Sp. Char.* Shell discoidal; whorls depressed or flattened at the sides, with a rather narrow rounded back. The sides of the shell ornamented with numerous nearly equal and closely arranged ribs, all of which are slightly arcuated, and pass over the back or dorsal edge; umbilicus wide and deep, allowing half the inner whorls to be exposed; sides of the whorls around the umbilicus steep-sided, rounded, or subangular; aperture broadly oval, the outer whorl embracing two-thirds of the next inner whorl. The ribs at the terminal portion of the last or body-chamber are somewhat unequal and coarser.

*Obs.* I have searched every available source for information relative to this shell, and cannot recognise any species approaching it in the Cretaceous rocks of Europe, India, or America. It has some affinity with *A. asterianus*, D'Orb., but wants the tubercle around the umbilicus; and the ribs are greatly bent or slightly sigmoidal, whereas in *A. asterianus* they are straight. It also resembles, in the ribs, some forms or varieties of *A. Herveyi*, but is not so tumid a shell. It occurs associated with *A. Beudanti*, D'Orb., *Anciloceras* and *Inocerami*, in the Hughenden Beds. (*Etheridge*.)

*Loc.* Hughenden (*The late R. Daintree*; *G. Sweet*—Colln. Sweet, Melbourne).

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\* Quart. Journ. Geol. Soc. 1855, xi., t. 11, f. 3a and b.

AMMONITES SUTHERLANDI, *Etheridge*, Pl. 29, fig. 6.

*Ammonites Sutherlandi*, *Etheridge*, Quart. Journ. Geol. Soc., 1872, xxviii., p. 345, t. 21, f. 4.

*Sp. Char.* Shell discoidal; whorls<sup>•</sup> three or four, with flattened sides and six or seven transverse wavy furrows on the outer whorl; these are slightly inflected forwards on the sides of the shell, and pass over the back at right angles to the keel; back sharply convex; the surface of the shell appears to have been marked by, or ornamented with, fine lines or striæ apparently arranged at a different angle from the sulci or furrows. Umbilicus small, well exposed, its walls rounded; aperture oval, elongated, or acutely ovate. (*Etheridge*.)

*Obs.* A very small portion only of the shell remains upon the side of the outer whorl, between the last two sulci, and shows faintly the fine undulating lines. The sutures are so indistinctly marked that the shell cannot be referred to any known species.

*A. Sutherlandi* has affinity with *A. cassida*, *Raspail*, from the Neocomian,\* but the sulci or furrows are fewer and wider, and the umbilicus smaller. None of the group *Ligati*, in the fine Indian Collection named and described by *Ferd. Stoliczka*, affords any clue to the form from Queensland, although some twenty-eight Indian species belong to this group. The smallness of the umbilical cavity and depth of the outer whorl remove this form from any species with which we can ally or compare it. (*Etheridge*.)

*Loc.* Marathon Station (*The late R. Daintree*; *G. Sweet*—Colln. *Sweet*, Melbourne).

AMMONITES SUTHERLANDI, *McCoy*, MS.

*Ammonites Sutherlandi*, *McCoy*, Trans. R. Soc. Vict., 1868, viii., Pt. 1, p. 42.

*Obs.* The only information we have regarding this Ammonite is the following passage by Prof. Sir F. McCoy:—"A new small species like the French *A. Parandieri*,† of the Gault." Sir F. McCoy's name, although having precedence over that given by Mr. R. Etheridge, F.R.S., in point of time, cannot retain its position, simply from the want of adequate description, and is, in fact, merely a manuscript name. It is just possible that both Authors have had the same species before them. Prof. McCoy compared his shell to *Ammonites Parandieri*, to which Mr. Etheridge's figure also bears considerable resemblance. Both the latter shells have similar wavy furrows, but in Mr. Etheridge's species the umbilicus is very much more concealed. As both shells, should they prove distinct, cannot retain the same name, a new one for McCoy's MS. *A. Sutherlandi*, will be required. It is to be regretted that material is not forthcoming for a full and proper description.

*Loc.* Base of Walker's Table Mountain, Flinders River (*Messrs. Sutherland and Carson*—National Museum, Melbourne).

Genus—HAMITES, *Parkinson*, 1811.

(Org. Remains, liii., p. 144.)

HAMITES ? LAQUEUS, *sp. nov.*, Pl. 42, figs. 14 and 15.

*Sp. Char.* Shell oval, link-shaped, but the two extremities free, no helix or involute portion; section at the older or proximal end nearly round, but compressed and oval at the younger or distal extremity. Surface of the older portion with close, encircling, usually simple, but occasionally bifurcating costæ, which gradually broaden out as the shell expands, and become sharp and erect with wide intervals or valleys; costæ on the dorsal side horizontal or very slightly concave, and nearly horizontal on the

\* Lycée, p. 115, No. 2; Ann. Sci. d'Observation, t. iii., Pl. 11, f. 3.

† D'Orbigny Pal. Franç. Terr. Cret., i., pp. 129 and 276, t. 38, f. 7-9.

ventral side, slightly sigmoidally curved on the flanks; tubercles occasionally developed on the older ribs, a line bordering the siphuncle on each side, and one, or sometimes two, on each flank; siphuncle small; chambers about two and a-half lines thick.

*Obs.* This peculiar shell is provisionally referred to *Hamites*, and is only known to me in the semi-convolute link-like form figured. The above description, therefore, only applies to specimens in such a condition. In an ordinary *Hamites* the two extremities are returned and approach one another in the same plane, the small or older end being again recurved on itself. The returning is so arranged that the growth of the individual could go on uninterruptedly from the one extremity without interfering with that of the other. In the present shell, however, the curvature is such that the extremities, being in the same plane, approach one another, so that in its present state of preservation a disunited link is formed. The first example of this I took to be either a malformation or one in which fracture had displaced one or other of the ends. But as there is no trace of misplacement, and as other individuals are exactly similar, neither of these hypotheses will hold, and we can only regard it as a particular feature of the species. At the same time, it is manifest that if the younger end continued to grow in the same plane and direction it would ultimately abut against the older and smaller extremity. To what distance the latter extended before the crozier, or initial point, as the case may be, would be reached, it is impossible to say, as all the specimens are broken short off when the two portions approach one another. At the rate of attenuation the proximal end could not have been greatly extended, probably not more than three inches in the largest example.

In the figured specimen the distal or larger end has rather the appearance of a terminal growth, but there is no trace of a definite margin.

One specimen possesses the proximal end tuberculated, but other examples do not show such ornament.

It would appear that the present species falls more readily into *Hamulina*\* rather than *Hamites*. In the former the shell is only once bent upon itself, the parts not in contact, and is without a "crozier," but, unfortunately, D'Orbigny is said by Pictet† to have abandoned his genus and it has probably, therefore, little stability. The curvature of the shell being in one plane renders a comparison with *Helicoceras* useless.

*Loc.* Tower Hill, Landsborough River (*The late R. Daintree*—Queensland Mus.); Warrego River—Queensland Mus.; Wellshot Run, near Barcardine (*A. Lyburner*).

*Genus*—*ANCYLOCERAS*, D'Orbigny, 1842.

(Pal. Franç. Terr. Crét., i., Pt. 2, p. 491.)

*ANCYLOCERAS FLINDERSI*, McCoy, Pl. 33, fig. 3; Pl. 34, figs. 5-8.

*Ancyloceras Flindersi*, McCoy, Ann. and Mag. Nat. Hist., 1867, xix., p. 356.

" " Etheridge fil., Journ. R. Soc. N. S. Wales, 1883, xvii., p. 89, 2nd pl. (upper fig.)

*Obs.* This species has never been described in detail, but Sir F. McCoy says it exceeds the *Ancyloceras gigas*, Sby., in size, and differs by having the transverse ribs larger and forking on the sides, and the presence of a row of large compressed tubercles on each side of the back. He further considers its nearest ally to be the *Ancyloceras Taberelli*, Astier, of the French Lower Greensand. The type in the National Museum, Melbourne, to which access was kindly given me by Sir F. McCoy, is a fragment eight inches long, with tubercles along the sides of the back. From each of these two to three ribs arise passing to the flanks. The ribs on the back are double.

\* D'Orbigny, Prod. Pal. Strat., 1852, ii., p. 66.

† Traité de Pal., ii., p. 707.

In a collection of Australian fossils forwarded to me, when in London, by Prof. Liversidge, I identified what was believed to be a large fragment of this species from Landsborough Creek. I remarked, "Although only a very small portion of the entire shell, it represents an individual of some size, in which the ribs fork on the sides, as described by McCoy, and with a row of large, much compressed tubercles on the sides of the back. The section of our specimen is elliptical, but unfortunately that of *A. Flindersi* is not given by McCoy."

Additional examples of an *Ancyloceras*, or *Crioceras*, have been obtained from the strata of Aramac Well in which some of the ribs do fork, as described by McCoy, but not all of them; and there is a clearly marked row of tubercles along each side. The specimens are, therefore, presumed to be *A. Flindersi*. The following facts are gathered from them:—

The section was egg-shaped, or elongately pyriform, with flat sides, sloping away rapidly to the narrow back, the dorsal side being broad. The ribs are close in the young state, widening with age, slightly sigmoidal on the flanks, where they bifurcate, each rib on arriving at the edge of the back being enlarged into a tubercle. These, in the young state, are blunt and depressed, but with advanced age becoming more compressed fore and aft. In the older shells also, the ribs become less conspicuous in crossing the flat narrow back.

The septa are highly complicated, and much broken up. The siphonal saddle is short, whilst the ventral lobes have two chief divisions, or fringes, the outer the longest; the ventral saddles are quadripartite, having two chief subdivisions, separated by a lobe, consisting of a long terminal, and two lateral fringes; each subdivision is itself split into two smaller saddles, and much pectinated. The superior lateral lobes are very large and long, and occupy as nearly as possible the centre of each flank of the shell, the body of each lobe being long and separated into two large forks, each of which is again, in its turn, slit into two spreading highly pectinated branches. The principal lateral saddle more or less resembles the ventral saddle in its construction; the inferior lateral lobe is long and narrow, terminating in two chief side branches and a central prolongation; the second lateral saddle is rounded and short, of two divisions separated by a lobe somewhat similar to, but smaller than the lobe subdividing the ventral saddle.

The chief point in the septal structure of *A. Flindersi* is the extreme depth and development of the superior lateral lobe and its ramifications. Each lobe occupies a large part of the flank, and in full-grown individuals extends over the width of four ribs.

*Loc.* Base of Walker's Table Mountain, Flinders River (*Messrs. Sutherland and Carson*—Colln. National Museum, Melbourne); Landsborough Creek, Thomson River (*Prof. A. Liversidge*—Colln. Sydney University); Aramac Well, at two hundred and twenty-four feet, and two hundred and thirty-eight feet respectively (*S. Sharwood*).

#### ANCYLOCERAS TAYLORI, *sp. nov.*, Pl. 42, fig. 13.

*Sp. Char.* Shell small, elongate; spire tightly coiled, of about two, or two and a-half whorls; projected limb gradually increasing in size, not placed precisely at right angles to the spire, but rather obliquely bent towards it; "crozier," or recurved distal end not preserved; costæ simple, without tubercles, becoming more obliquely directed as the limb is ascended, rounded, and separated by narrower sulci.

*Obs.* The proximal coil of the shell would indicate *Ancyloceras* rather than *Hamites* for the reception of this fossil. It may be only the young of some other form,

but if adult is distinct from any hitherto described Australian species. It is noticeable for the extreme simplicity of its structure, and in this respect would perhaps be included in the group of *Ancyloceras pulcherrimus*, D'Orb.\*

The name is proposed in honour of my old Friend and former Colleague, Mr. Norman Taylor.

*Loc.* Head of the Walsh River † (Colln. Queensland Mus.).

*Genus*—*CRIOCERAS*, *Leveillé*, 1873.

(Mém. Soc. Géol. France, ii., p. 313.)

*CRIOCERAS AUSTRALE*, *Moore*, sp.

Pl. 30, fig. 7; Pl. 31, fig. 1; Pl. 32, figs. 1-4, ? 5; Pl. 33, fig. 2.

*Crioceras australe*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 257, t. 15, f. 3.

„ „ Waagen, Pal. Indica (Jurassic Fauna of Kutch), Cephalopoda, 1875, i., No. 4, p. 246, t. 60, f. 1, a-c.

„ *Jackii*, Etheridge fil., Proc. R. Phys. Soc. Edinb., 1880.

„ *australe*, Ten. Woods, Journ. R. Soc. N. S. Wales, 1882, xvi., p. 152, t. 10, f. 5 and 6.

„ „ Ratte, Proc. Linn. Soc. N. S. Wales, 1886, i., p. 133, tt. 1 and 2.

Compare *Crioceras irregulare*, Ten. Woods, *Ibid.*, p. 151, t. 8, f. 2.]

*Sp. Char.* Shell attaining a very large size, with the whorls massive, broad, close but not touching, from six to eight in number, the first two or two and a-half whorls tuberculate; back very convex; round or slightly flattened at the sides; dorsal or inner side flat or concave; section roundly deltoid; siphuncle of medium size for that of the shell, immediately below the outer test on the back; septa thick and strongly developed, almost flat in the centre; the ventral or siphonal saddle is short in proportion to the inferior lateral saddles. The latter are divided into two strong main branches, each again bifurcating. The second inferior lateral saddles appear to be of equal length with the first, and of similar construction. The ventral lobe is deep, with short branches on each side the dorsal saddle; the digitations are numerous; the costæ showing, and very well developed, horizontal on the ventral side or back, slightly sigmoidal on the flanks, and concave forwards on the dorsal side; simple, or bifurcating, when the latter, consisting of a primary rib, and a subsidiary one at its side, tuberculate, in the young state; in the latter condition the primary costæ are of two sizes, the non-tuberculate ribs being all of one size, whilst those bearing the tubercles are larger, and separated one from the others, sometimes by two and sometimes by three of the former; costæ in the young shell close together, contiguous, but gradually widening out with age and becoming separated by wide rather concave sulci, which become wider still as the mouth is approached; tubercles blunt and node-like, arranged in six rows, two on each side of the flank and two on the back, those on the sides becoming less apparent, and disappearing about the end of the second volution; test striated parallel to the costæ.

*Obs.* Through a fine series of specimens forwarded to me by Mr. C. De Vis, supplementing additional ones collected by my Colleague, I am able to trace this species from a comparatively young state (Pl. 30, fig. 7), in which the tubercles are present as little fine nodes, up to the fine specimen figured on Plate 31, of half the natural size; and further, to show that in all probability Moore's *C. australe* and *C. Jackii* (mihi) are identical.

As originally described, *C. Jackii* was known either from the inner tuberculated whorls of larger and older specimens, or from young individuals in which the tubercles were very pronounced. In the latter condition the costæ are close, sharp, and

\* Pal. Franç. Terr. Crét., i., t. 121, f. 3.

† The head of the Walsh River is in Palæozoic and Plutonic rocks. The locality is probably lower down the Walsh. (*R.L.J.*)

moderately straight, but as the shell grew they became rounder, flatter, further apart, abrupt on their front sides, gradually shelving off into the concave sulcus, and sigmoidal in direction on the flanks. In this condition the shell becomes *C. australe*, Moore. The tubercles are occasionally retained to the fourth whorl before they disappear, but in most examples they are not visible beyond the second or second and a-half whorl. In no less than four specimens there is no sign of tubercles at all, even in the flattened, rounded ribs in advanced age, which gradually become further apart as the mouth is approached, even to the extent of a quarter of an inch. The costæ bearing tubercles are always larger and thicker than the non-tuberculate. The number of secondary ribs between those bearing tubercles varies from two to five. Much variation also took place in the contiguity of the whorls, some being inrolled much more closely than others, and frequently the whorls to all appearance look as if touching, but on fracturing the specimens they are all found to be separate.

*Crioceras australe* attains to very large dimensions. The subject of Pl. 31, fig. 1, measures twelve and a-quarter inches in one direction by nine and a-half in the other. Another before me is nine inches by seven and a-half, the breadth of the last whorl from the middle of the back to the umbilical edge being three and a-half inches. But in the Australian Museum is a huge specimen described by the late Mr. F. Ratte, consisting of about half the entire shell, showing the following measurements:—

	Ft. in.
Diameter ... ..	1 11½
Circumference of periphery ... ..	3 9½
Girth of older portion ... ..	2 2½
Distance apart of the costæ at the younger end ... ..	0 4
Depth of valleys between the costæ at the younger end ... ..	0 1

Mr. G. Sweet obtained another very large example from the Maranoa River, with a diameter of two feet nine inches and even then imperfect. The costæ or ribs are from two to three inches apart.

Mr. Moore states that in his specimen the mouth measured seven and a-half inches in depth by seven in breadth. The dorsal side of each whorl is flattened, with a space in the middle line corresponding to the dorsal lobe, and bounded by two impressed lines.

One word more about *Crioceras Jackii*. Moore's description and figure are quite inadequate for the proper recognition of *C. australe*, and I believe I should, therefore, have been justified in retaining mine. But it is difficult to believe that two large species could have existed in the same area, so very alike and only known to differ in the young state. The figure, however, given by Dr. Waagen is probably conclusive, for in this case there are portions of the large outer whorls of *C. australe*, embracing an inner fragment resembling *C. Jackii*. Such conditions are seen in other *Crioceri*, such for example as *C. Emerici*,\* a Neocomian species. His statement that when complete the shell attained nearly twice the dimensions of the huge *C. Bowerbanki*, of the British Lower Greensand, would appear to be borne out by the size of the shell already referred to as in the Australian Museum. Mr. R. Etheridge, F.R.S., also recognised a large *Crioceras* in Mr. Daintree's Collection, measuring little less than twelve or fourteen inches in diameter, which may possibly be this species.

The subdivisions of the septa have been excellently figured by Mr. Ratte, from the large specimen in the Australian Museum, but from advanced age they are more complicated than those shown in Pl. 32, fig. 4.

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\* Quenstedt, Handb. Petrefactenkunde, 1885, Atlas, t. 45, f. 21.



*Loc.* Upper Maranoa District (*The late Rev. W. B. Clarke*); Tate River (*A. C. Macmillan*); Walsh River (*Hon. A. C. Gregory and Queensland Museum*); Palmer River (*The late Rev. J. E. T. Woods*); Landsborough Creek, Thomson River (*Prof. A. Liversidge*); Wollumbilla (*G. Sweet—Colln. Sweet, Melbourne*); Maranoa River, about one mile north of Mitchell Bridge (*G. Sweet—Colln. Ibid.*).

*CRIOCERAS IRREGULARE, Ten. Woods.*

Pl. 33, fig. 1; Pl. 42, fig. 16; Pl. 32, fig. 5 ?.

*Crioceras irregulare*, Ten. Woods, Journ. R. Soc. N. S. Wales, 1882, xvi., p. 151, t. 8, f. 2.

*Sp. Char.* Shell loosely and irregularly coiled; whorls one and a-half, quite free, but the distance irregular, much compressed at the sides; tuberculate in sixteen rows. The first six obsolete, tubercles, three on each side, conical, short, close on the sides, but at an interval on the dorsal edge, then disappearing except that a faint row seen near the end of the fragment after a long interval. Costæ of two sizes, the tuberculate ones large, and separated from one another by simple, narrow, round, undulating ribs, which vary in number between the tubercles from two to thirteen. (*Ten. Woods.*)

*Obs.* The above description is quoted from the late Rev. Mr. Woods's Paper word for word, and with identical punctuation. The latter, in the second sentence, seems to have become misplaced, because the sense and meaning of the paragraph does not appear to be continuous.

The figure of this species certainly represents a more loosely coiled shell than *C. australe*, but nevertheless the resemblance between the form of the costæ and arrangement of the tubercles is so conspicuously alike that a connection between the two cannot but be suspected. The original figure is given in Pl. 33, fig. 1, and here will be noticed the apparent tapering termination, or rather commencement, or nucleus, of the shell, this free and open state being quite different to anything yet noticed in *C. australe*, the initial portions of which are represented in Pl. 30, fig. 7, and Pl. 32, fig. 1. There are two, three, four, and six costæ at times between the larger node-bearing ribs, and these seem to occur irrespective of order (Pl. 33, fig. 1). This is the case in *C. australe*, and, as in that species, the nodes cease suddenly, and are confined to a limited portion of the surface only. Two very prominent nodes occur on the back (Pl. 42, fig. 16), one at each side, immediately below these (Pl. 42, fig. 16), and one or two on each flank (Pl. 33, fig. 1). Compare with this the ornamentation of *C. australe* (Pl. 32, figs. 1 and 2). The specimen referred to *C. irregulare*, from the Walsh River (Pl. 42, fig. 16), has the peculiarly flattened appearance, on its inner or concave side, which generally results from the close contiguity of another whorl, and therein still more indicating its probable relation to *C. australe*.

As figured by Mr. Tenison Woods, *C. irregulare* is decidedly after the type of *Crioceras latus*, Gabb,\* both in the enrolment of the whorls and form of ornament, but in Gabb's species the larger prominent ribs are farther apart.

*Loc.* Palmer River (*The late Rev. J. E. T. Woods*); Head of Walsh River † (*Hann's Expedition—Queensland Museum*).

\* Pal. California, t. 15, f. 25.

† The head of the Walsh River is in Palæozoic and Plutonic rocks. Probably the true locality is further down the river. (*R. L. J.*)

*CRIOCERAS, sp. ind.*, Pl. 33, figs. 4, 5, and 6.

*Ancyloceras* or *Hamites*, Etheridge fil., Journ. R. Soc. N. S. Wales, 1883, xvii., p. 89, 2nd Pl., bottom l.h. fig.

*Obs.* In 1883 I figured a fragment, provisionally referred to *Ancyloceras* or *Hamites*, but which I now think may be more appropriately referred to *Crioceras*. The ribs are in bundles of two or three, proceeding from a series of single nodes, or tubercles, on the flanks, arranged generally in a line along their centres, or coming close down to the dorsal (concave) margin. Here and there one of the ribs may be much stronger than the others (Pl. 33, fig. 4).

Another specimen has since come to light from the Aramac Well, in which the arrangement is similar generally, but slightly different in detail (Pl. 33, figs. 5 and 6). Here the tubercles are farther apart on the flanks; the ribs more commonly in bundles of two, this subdivision being remarkably well shown on the back, where also a double row of tubercles is visible. Further examples of these specimens, which are perhaps specifically identical, will be welcome.

*Loc.* Landsborough Creek, Thomson River, Pl. 33, fig. 4 (*Prof. A. Liversidge*—Colln. Sydney University); Aramac Well, at two hundred and eighty-four feet (*S. Sharwood*).

*CRIOCERAS EDKINSI, sp. nov.*, Pl. 30, figs. 8 and 9.

*Sp. Char.* Shell simple, of apparently not more than two volutions, in a more or less oval coil; section oval; dorsal and ventral lobes about equal, and much smaller than the lateral; dorsal and ventral saddles each divided into two branches, which bifurcate. Surface with equidistant, regular ribs, one becoming larger than the others at intervals, separated by equal interspaces; a row of very small tubercles on each side the back.

*Obs.* A small and pretty species of this genus, not exceeding three-quarters of an inch in diameter, resembling in the curvature of its shell, the *Crioceras irregulare*, Ten. Woods, but the size precludes any reference to this species. Had only a single specimen been present it might have passed for the young of that shell, but as the examples are numerous, and constant in their characters, they can only be regarded as adult individuals, and as such are certainly new to the Cretaceous rocks of Queensland.

*C. Edkinsi* is associated with a number of other shells, such as a small *Inoceramus*, possibly a *Nucula*, a small crushed Ammonite, of a strongly Gault *facies*, and casts of univalves, but the latter not in a good state of preservation. It is allied to, and very like *Ancyloceras Beyrichii*, Karsten,\* especially in the simple coiled whorls.

The name is given in honour of Mr. E. R. Edkins, who presented the specimens to the Queensland Geological Survey.

*Loc.* Well, seven miles east of Mount Cornish Homestead, near Muttaborra, at two hundred and thirty feet below the surface (*E. R. Edkins*).

## Family—NAUTILIDÆ.

*Genus*—*NAUTILUS, Bregnius*, 1732.

(Dissert. de Polythal.)

*NAUTILUS HENDERSONI, sp. nov.*

*Obs.* Fine examples were obtained too late for detailed description, but it may be sufficient to say now that they are after the general type of *N. elegans*. Named in honour of Mr. J. B. Henderson, M.I.C.E., Hydraulic Engineer to the Queensland Government, who has presented many fossils to the Geological Survey Museum. These will be described later. •

\* Géol. l'Ancien. Colombie-Bolivarienne, Vénézuëla, Nouv.-Grenada et Ecuador, 1886, t. 1, f. 4a.

*Loc. and Horizon.* Maxwellton, Flinders River, Lat.  $20^{\circ} 45' S.$ , Long.  $142^{\circ} 48' E.$  (*J. Burkitt*); Wellshot Run, Barcaldine, Lat.  $23^{\circ} 55' S.$ , Long.  $144^{\circ} 25' E.$  (*A. Lyburner*); Ilfracombe, Lat.  $23^{\circ} 30' S.$ , Long.  $144^{\circ} 45' E.$  (— *Sheehy*).

## Sub-Kingdom—VERTEBRATA.

### Class—PISCES.

### Order—CHONDROPTERYGII.

### Family—LAMNIDÆ.

### Genus—*LAMNA*, Cuvier, 1817.

(Règne Animal, ii., p. 126.)

### *LAMNA DAVIESII*, Etheridge *fil.*

*Lamna Daviesii*, Eth. *fil.*, Proc. Linn. Soc. N. S. Wales, 1888, iii., Pt. 1, p. 159, t. 4, f. 2 and 3.

*Sp. Char.* Vertebrae four inches high, three-quarters of an inch in length, and with a transverse diameter of more than two inches. Outline of the centrums oval, with a slightly concave surface. Peripheral fissures very narrow and numerous; margins of the centrums prominent and rounded.

*Obs.* The present very remarkable specimen consists of seven vertebrae of a Selachian fish, firmly united together, but slightly displaced obliquely from their normal position, and as a whole six inches in length. In all probability, from the difference in the height and transverse measurement, these vertebrae had to some extent an oval outline, but this may have been intensified by the oblique displacement they have undergone.

With our present unsatisfactory knowledge of the remains of this group of fish in bygone periods, it is difficult to decide on a genus for these remains, but there is a general correspondence to the excellent figures given by Agassiz of the vertebrae of extinct species of *Lamna*, for it is quite clear that the whole of each centrum was ossified, as in the family represented by the genus in question. According to Agassiz's statement as to the number of the peripheral fissures in the anterior, posterior, and abdominal regions of the column, the present specimen would be those of the abdominal.

It must be the representative of a very large fish. The Australian Museum contains a *Carcharodon Rondeletii*, about nine feet long, with vertebrae the centrums of which are about half the size only of those in this fossil. Judging by these measurements, it would appear to Mr. J. Douglas Ogilby, who has kindly gone into the question with me, that we have here the remains of a fish which must have been from eighteen to twenty feet long.

*Loc. and Horizon.* Richmond Downs, Flinders River (*C. W. De Vis*—Colln. Queensland Museum, Brisbane).

### *LAMNA APPENDICULATA*, Agassiz.

*Otodus appendiculatus*, Agassiz, Rech. Poiss. Foss., iii., p. 270, Atlas, iii., t. 32, f. 1-25.

" " Eth. *fil.*, Proc. Linn. Soc. N. S. Wales, 1888, iii., Pt. 1, p. 158, t. 4, f. 1.

*Lamna appendiculata*, Smith Woodward, Cat. Foss. Fishes Brit. Mus., Pt. 1, 1889, p. 393.

*Sp. Char.* A tooth of the upper jaw, nearly one inch in height from a line drawn between the fangs upwards to the apex, three-quarters of an inch across the root,

and rather less between the fangs. The upper margin of the root describes almost an ellipse, the fangs being thick and obtusely rounded. The crown is rather more than half an inch high, rather flattened on the inner surface, and gently arcuate from before backwards, with the lateral or cutting edges and the apex sharp. The basal cusps are small, but prominent and sharp, the posterior of the two being the larger.

This tooth is in all probability from the upper jaw, and from its arcuate outline somewhat posterior in position. The specimen was carefully compared with a large series of similar teeth from the Cretaceous rocks of England, and found to agree excellently with Agassiz's species, especially that form represented in his Pl. 32, f. 15, the present example being but slightly more arcuate.

*Loc.* Limestone at Kamilaroy, Leichhardt River, North-west Queensland (*R. L. Jack*).

## Order—GANOIDÆ.

### Family—ASPIDORHYNCHIDÆ.

*Genus*—*ASPIDORHYNCHUS*, Agassiz, 1833.

(Rech. Poiss. Foss., ii., Pt. 2, p. 135.)

*Obs.* Mr. R. Etheridge, F.R.S., has recorded\* the caudal portion of the vertebral column, and several of the peculiarly elongated scales of this genus. It is possible, however, that these fragments may belong to the following genus.

*Loc.* Hughenden (*The late R. Daintree*).

*Genus*—*BELONOSTOMUS*, L. Agassiz, 1844.

(Rech. Poiss. Foss., ii., Pt. 2, p. 140.)

*BELONOSTOMUS SWEETI*, *Eth. fil. and A. S. Woodw.*

*Belonostomus Sweeti*, *Eth. fil. and A. S. Woodw.*, Trans. R. Soc. Vict., 1892, ii. (2), Pt. 2, p. 1, t. 1.

*Obs.* For a full description of the remains of this fish the Reader is referred to the Paper by Mr. A. S. Woodward, F.Z.S., and the Writer. It is believed to be the largest species of the genus, measuring one foot three inches in length. It was a much less slender fish than the typical Jurassic species, *B. tenuirostris*, Ag., and *B. sphyronoides*, Ag., and the superficial ornament of the scales was much more conspicuous and elaborate. The only *Belonostomus* which appears to be at all comparable to the Queensland species is the large *B. Comptoni*, Ag., sp., from Brazil, the scale sculpture of the latter being equally conspicuous with our species, with this exception, that the principal flank scales never appear to exhibit the prominent, fine, transverse striations so characteristic of the hinder margin of all the flank scales of *B. Sweeti*.

*Belonostomus* lived in the same geological periods in Europe, India, and Brazil, and its discovery in Queensland is thus of great interest, as extending still further the ascertained geographical range of the genus during Mesozoic times.

*Loc.* Hughenden (*G. Sweet*—Colln. Sweet; and *D. P. Ryan*—Colln. Geological Survey, Queensland).

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\* Quart. Journ. Geol. Soc., 1872, xxviii., p. 346.

## Class—REPTILIA.

## Order—CHELONIA.

## Family—CHELONIDÆ

*Genus*—**NOTOCHELONE**, *Lydekker*, 1889.*Notochelys*, Owen (*non* Gray), Quart. Journ. Geol. Soc., 1882, xxxviii., p. 178.*Notochelone*, Lydekker, Geol. Mag., 1889, vi. (3), p. 325.

,, Lydekker, Cat. Foss. Reptilia and Amphibia Brit. Mus., Pt. 3, 1889, p. 70.

**NOTOCHELONE COSTATA**, *Owen*, sp.*Notochelys costata*, Owen, *loc. cit.*, p. 178.

,, ,, Eth. fil., Geol. Mag., 1886, iii., p. 329.

*Notochelone costata*, Lydekker, *loc. cit.*, pp. 325 and 70.

*Obs.* The remains of this Chelonian consist of the anterior part of the carapace and plastron. These portions were not united by bone, so that no affinity can exist with the freshwater and terrestrial genera. It appears to be more nearly allied to the marine Turtles (*Chelone*).

Sir Richard Owen states this to be the first evidence of a fossil Chelonian obtained in Australia, but he appears to have overlooked the late Mr. Krefft's discovery of the carapace of a freshwater species in the Wellington bone-caves \* and Dr. E. P. Ramsay's description of the pelvis of a Turtle from Lord Howe Island.†

Furthermore, a marginal scute of a Chelonian from Westbrook, a tributary of Oakey Creek, Condamine River, has long been in the collection of the Geological Department of the British Museum, presented thereto by Dr. G. Bennett.

The district in which this interesting fossil was found abounds in organic remains of Cretaceous age, and there is nothing in the structure of this Chelonian which would militate against its having lived at that period of the earth's history.

*Loc.* Landsborough Creek, Thomson River (*Prof. A. Liversidge*—Colln. Sydney University).

Order—**ICHTHYOPTERYGIA.***Genus*—**ICHTHYOSAURUS**, *König*, 1820.

(Icon. Foss. Sectiles, t. 19, f. 250.)

**ICHTHYOSAURUS AUSTRALIS**, *McCoy*.*Ichthyosaurus australis*, McCoy, Ann. Mag. Nat. Hist., 1867, xix., p. 355; *Ibid.*, xx., p. 196.,, ,, McCoy, Trans. R. Soc. Vict., 1868, viii., Pt. 1, p. 42; *Ibid.*, 1869, ix., Pt. 2, p. 77.

,, ,, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 228.

*Sp. Char.* Centrums of the vertebræ four inches wide, three inches deep, and one and a-half inches long, deeply biconcave, and with conical articular surfaces; paddles with eight rows of phalangeal joints; teeth with a rough, bony, square base, above which the smooth base of the crown has a circular section, the remainder of the conical crown being marked with close irregular obtuse ridges, with narrow intermediate impressed lines; eyes five and a-half inches in antero-posterior diameter, the pupillary opening two inches, and the sclerotic divided into about thirteen pieces. (*McCoy*.)

*Obs.* This is said by Sir F. McCoy to be one of the largest species of the genus, being twenty-five feet long. The teeth resemble those of *I. campylodon*, Carter, from the English Chalk.

\* Australian Vertebrata, Foss. and Recent, 1871, p. 39.

† Proc. Linn. Soc. N. S. Wales, 1882, vii., Pt. 1, p. 86.

It would be a great boon if Prof. McCoy would publish a full description of this interesting Reptile, as quite recently fine additional remains of *I. australis* have come to hand through the labours of Messrs. J. Burkitt, J. Hugh Moor, and W. L. Mackinnon. The first of these gentlemen has obtained the snout portion of a large head with powerful teeth and a number of united vertebræ; the second a portion of a skull showing the orbit, with sclerotic plates *in situ*, and a large number of disjointed centrums of vertebræ; whilst the last-named collector has forwarded other disarticulated centrums, which, although smaller, have every appearance of being those of this species.

*Loc.* Base of Walker's Table Mountain, Flinders River (*Messrs. Carson and Sutherland*—Nat. Mus., Melbourne); Bed of Flinders River, thirty-five miles below Richmond Downs, approximately Lat. 20° 37' S., Long. 142° 43' E. (*J. Burkitt*); Flinders River, at Manfred Downs, approximately Lat. 20° 5' S., Long. 141° 45' E. (*J. Hugh Moor*); Glendower, Upper Flinders (*W. L. Mackinnon*).

#### ICHTHYOSAURUS MARATHONENSIS, *Etheridge fil.*

*Ichthyosaurus marathonsis*, Eth. fil., Proc. Linn. Soc. N. S. Wales, 1888, iii., Pt. 2, p. 405, t. 7.

*Obs.* The fossil consists of that part of the upper and lower jaws of a large skull anterior to the nostrils. It measures ten inches in length, and exhibits the greater portion of the right maxillary and dentary bones, and a portion of the left. At the anterior end the specimen has been broken off short, immediately posterior to the union of the rami, and at the hinder end just anterior to the outer termination of the nasal bones. At the former the snout is three and a-half to four inches in transverse measurement, and at the latter point four and a-half inches. There are thirty teeth in all preserved, ten implanted in the pre-maxillary, and eleven in the dentary.

Both bones are longitudinally channelled by a deep semi-interrupted groove, similar to that seen in other species of *Ichthyosaurus*.

The teeth are of medium size, but larger than in some species, measuring from an inch to an inch and a-quarter from the alveolar edge to the apex of the crown, but including the implanted base, one of the foremost teeth measures an inch and three-quarters in length. They increase in diameter and stoutness from before backwards, are conical sub-circular in section, with a non-trenchant and apparently straight crown. The enamel is ornamented with grooves and ridges, but there is no evidence that the crown apices were devoid of these; but, on the contrary, the upper portions of the crown and the base of the teeth above the alveolus appear to be more strongly ridged than does the middle line of each tooth. In the most anterior tooth but one preserved in the pre-maxillary, having a sectional diameter of half an inch, there is a pulp cavity of three-sixteenths of an inch.

In a transverse section of the posterior end the following facts are discernible. The breadth of the pre-maxillary across the top of the alveolar cavity is one inch. On the outer border the external groove traversing this bone longitudinally leads into a well-marked cavity, the exterior alveolar wall being thin, but this is perhaps owing to some extent to the lateral abrasion the specimen has undergone. The alveolus cut by the section is five-eighths of an inch wide and an inch in depth. From the thickened and enlarged lower end the inner wall of the bone is directed upwards in a fairly straight line until it reaches a point on a level with the upper end of the alveolus. Here it takes a well-marked bend inwards to above the cavity of the external groove; thence it bends outwards to become the median surface for union with that of the left pre-maxillary. The inner alveolar wall descends at least four-eighths of an inch lower than the outer one. There is no indication of the nasals. In the lower jaw the lower portion of the dentary is not preserved, having flaked off from the specimen, but this bone

would probably present a deeply sigmoidal outline if whole. It now measures through the base of the alveolus an inch and one-eighth, the latter being six-eighths of an inch deep. From the bottom of the alveolus through the inner portion of the dentary there is only a thickness of three-sixteenths of an inch. The upper element of this bone is nearly as correspondingly thick as the lower portion of the pre-maxillary, whilst that part below the alveolus, including the portion split off, is at least one inch in height. The external longitudinal groove leads into a sac, which, with the passage uniting the latter to the outer groove, almost completely cuts the bone itself in half, and strongly resembles the similar vascular canal in the pre-maxillary. We also notice in this section the difference in the angle of the alveolus in the upper and lower jaws, and doubtless the curved outline of the lower teeth is a provision of nature to bring them into apposition with those of the upper jaw, which are straighter and set at an entirely different angle.

I do not see any trace of the splenial bones, the fracture which severed this portion of the jaws from the remainder of the head having taken place too far forward, unless the small fragment of bone at the very bottom of the section in the middle line represents the anterior termination of the right splenial.

Since Prof. Sir F. McCoy's first announcement of Enaliosaurian remains in Queensland very little seems to have been done towards working out the distribution of this important group of reptiles in Australia. The details of his *Ichthyosaurus australis* given by McCoy are so meagre that it is with the greatest difficulty a comparison can be instituted with any other remains. The presence of the casts in the Australian Museum would have rendered this task easier than it otherwise could have been had that portion of the head mentioned by McCoy as bearing teeth been present, but the cast in the Museum consists of a portion of the right side included between the posterior margin of the orbit to about half the length of the nostrils, measuring one foot in length by seven and a-half inches high. This portion of the cranium is, of course, much posterior to that here described, but, judging from the relative proportions of the two specimens, I am inclined to regard the present fragment as a portion of a species quite as large as Sir F. McCoy's, and it is possible they may be identical.

The general proportions of this snout resemble those of *I. campylodon*, Carter, from the English Chalk, and there is present in this species a well-marked vascular channel \* along the pre-maxillary and dentary bones, just as we see it here. Describing this, Sir Richard Owen says: "Opposite the origin of the inner alveolar plate the pre-maxillary is traversed by a straight longitudinal groove, four lines in breadth, which contracts as it advances forwards."† Touching the similar groove seen along the dentary, he adds: "The outer part of the dentary at the hinder fracture is six lines in thickness, smooth, and convex on its outer side, which is traversed by a longitudinal groove, which also slightly narrows as it advances."

As well as in *I. campylodon*, this groove is shown in Sir R. Owen's figures of the jaws of *I. communis*‡ and *I. platyodon*,§ Liassic species.

Sir F. McCoy notes the resemblance of the teeth of his *I. australis* to those of *I. campylodon*, previously referred to, a likeness which is also perceptible in our species. I am unable, however, to institute a comparison between the latter and *I. australis*, from the fact that the casts in the Australian Museum do not exhibit the teeth.

\* Mon. Foss. Rept. Cret. Form., 1851, t. 25, fig. 1g.

† Loc. cit., p. 75.

‡ Mon. Foss. Rept. Liassic Form., t. 24, f. 2.

§ Ibid., t. 31, f. 2.

The upper surface of the pre-maxillary, judging from the section of the right one, would form rather a narrow arch, differing very much in this respect from the broad semi-circular outline of *I. campylodon*.

In describing the Fossil Reptilia of New Zealand, Sir James Hector, F.R.S., has applied the name of *Ichthyosaurus australis*\* to some remains found in that country. Sir F. McCoy's name having priority, that of the New Zealand species will need alteration.

*Loc.* Marathon Station, North-Central Queensland (*C. W. De Vis*—Queensland Museum, Brisbane).

## Order—SAUROPTERYGIA.

*Genus*—*PLESIOSAURUS*, *Conybeare*, 1821.

(*Trans. Geol. Soc.*, v., Pt. 2, pp. 560 and 581.)

*PLESIOSAURUS MACROSPONDYLUS*, *McCoy*.

*Plesiosaurus macrospondylus*, McCoy, *Ann. and Mag. Nat. Hist.*, 1867, xix., p. 356; *Ibid.*, xx., p. 196.

" " McCoy, *Trans. R. Soc. Vict.*, 1868, viii., Pt. 1, p. 42.

*Sp. Char.* Cervical vertebræ only known; each centrum three inches long, three wide, and two and a-half inches deep. (*McCoy*.)

*Obs.* Sir F. McCoy remarks that this appears to be specifically distinct from *P. Sutherlandi*, by the extraordinary rugosity of the edges of the articular ends of the centrum, as in *Plesiosaurus rugosus*, each of which presents a remarkably elongated form. Our present knowledge of *P. macrospondylus* is very inadequate.

*Loc.* Base of Walker's Table Mountain, Flinders River (*Messrs. Carson and Sutherland*—National Mus., Melbourne).

*PLESIOSAURUS SUTHERLANDI*, *McCoy*.

*Plesiosaurus Sutherlandi*, McCoy, *Ann. and Mag. Nat. Hist.*, 1867, xix., p. 356; *Ibid.*, xx., p. 196.

" " McCoy, *Trans. R. Soc. Vict.*, 1868, viii., Pt. 1, p. 42.

" " Eth. fil., *Ann. Report Dept. Mines N. S. Wales for 1887 [1888]*, p. 167, Pl. 1, f. 1-4.

*Obs.* Sir F. McCoy has very briefly described the trunk vertebræ of this reptile—too briefly for his remarks to be of much service in determining the species. He states that the length of the centrum is two and a-quarter inches, the width three and three-quarters, and the depth two and a-half inches. Those measurements, Prof. McCoy thinks, resemble those of *P. australis*, Owen, from New Zealand, but the proportions are obviously different.

Thanks to the kindness of Sir F. McCoy, in forwarding his original specimens for comparison, I have been able to identify with his species some additional remains from Central Queensland. The fossils consist of the centruns of cervical vertebræ, without processes. They are transversely ovate or ellipsoidal in outline, two and an eighth inches long, four and a-half wide, and two and three-quarters high. The upper surface is depressed convex, but below the middle line is sub-angular. The venous openings are two, large and distinct, the surface of the vertebræ exterior to them, and between them and the pleuræ, more or less concave. The centruns have a well-marked, rather flattened articular surface, half an inch wide, but with sharp, erect, non-rugose external edges. Within the articular surface each centrum is depressed, but not actually concave, in fact more flattened than concave, three inches by one and a-half, smooth, and with the faintest trace of a tubercle or prominence. The neurapophysial and pleurapophysial surfaces are contiguous to one another; and the last-named, although lateral in position,

\* *Trans. N. Zealand Inst. for 1873 [1874]*, p. 155.



are nearer to the upper than the lower surfaces of the centruns, and they in no way hide any part of the inferior surfaces of the latter. The neurapophysial surfaces were long fore and aft, and somewhat narrow, but those of the pleurapophysial, on the other hand, were large and oblique, and somewhat narrow.

In *P. australis*, Owen, there are two large and two small venous foramina instead of only two large, as in the present case. Amongst other New Zealand species is *P. crassicostatus*, Owen,\* the centruns of which, according to Sir James Hector, "are deeply excavated beneath, with two venous foramina. The articular surfaces are elongately transverse, forming a contracted oval, and only moderately concave with rounded margins."† In the Queensland bones the margins are distinctly flattened, and the ventral surface, instead of being excavated, is convex. The concavity mentioned by Hector is visible in his figures, and gives a character to the vertebræ not to be mistaken or overlooked. Furthermore, the centruns of the former have no definite tubercle, which is present in *P. crassicostatus*.

*Loc.* Walker's Table Mountain, Flinders River (*Messrs. Carson and Sutherland*—National Mus., Melbourne); Pitchery Creek, Barrington's Station, Central Queensland (*H. J. W. Crummer*—Mining and Geol. Mus., Sydney); Marathon (*G. Sweet*—Colln. Sweet, Melbourne).

Some additional remains of *Plesiosaurus* have lately been described by the Writer,‡ consisting of vertebræ and ribs confusedly intermingled. No good purpose would be served by applying names to these bones, but the following is a general description of the fossils.

In this mass we have the remains of at least four vertebræ, which, judging from the form and attached processes, are clearly those of the dorsal series. Only one, however, is in any degree perfect, the others having undergone fracture, and all abrasion. Intermingled with the vertebræ are portions of ribs, particularly two well-marked fragments, and an articular end of a third.

The most perfect vertebra is five and a-quarter inches high, but the inferior margins of the centrum are not preserved, so that this measurement is somewhat under that of the perfect size of the bone. The edges of the articular surfaces are much worn and decorticated, but, as preserved, the entire centrum is an inch and a-half in height, and the concave articular surface an inch and a-quarter. The length of the centrum, fore and aft, is an inch and three-quarters, and the breadth, or width, two inches. The neural spine, from the upper margin of the canal in the middle line, is three and three-quarter inches in height, but is shortened by fracture; it is sharp, thin, and laterally compressed. At its base the spine is an inch and a-half thick from before backwards; but at the broken upper extremity, the transverse width is a little less than an inch. It is very erect, and does not appear to have any posterior inclination, but the posterior zygapophysis would overhang the succeeding centrum to a slight extent when in apposition with it. The neural canal itself is broadly oval, measuring an inch in its longest diameter; but the pre-zygapophysis is not preserved. The diapophysial support of the rib visible is placed very high up, and is directed backwards and upwards and forms the entire costal surface; below this point the surface of the vertebra is much hollowed. The diapophysis is ledge-like, flattened to some extent above and below,

\* Geol. Mag., 1870, vii., p. 53.

† Trans. N. Zealand Inst., 1874, vi., p. 342.

‡ On additional Evidence of the occurrence of *Plesiosaurus* in the Mesozoic Rocks of Queensland. *Proc. Linn. Soc. N. S. Wales*, 1888, iii., Pt. 2, p. 410, t. 8.

with the ridge connecting its under portion to the lateral surface of the centrum very ill-defined. The actual surface for the rib-articulation is not preserved, through fracture.

The remains of the ribs consist either of portions of two or else one broken in half with the severed ends contiguous to one another. One of these pieces is six inches in length, the other six and a-half inches, the former practically straight, the latter curved, and both laterally compressed. When united these would represent a rib from thirteen to fourteen inches long. The third example, previously referred to, represents the proximal end of a rib, with a simple expanded termination about three-quarters of an inch in diameter.

Taking into consideration the general character of these bones and the position of the diapophyses, little doubt can be entertained that we are dealing with vertebræ of the dorsal series. In describing those of *Plesiosaurus dolichodeirus*, Conyb., Sir R. Owen says—"The transition from the cervical to the dorsal series is effected by the usual elevation of the costal surface by gradational steps continued through about five vertebræ, until a single costal surface is presented by a large diapophysis from the neural arch."\* This is precisely what we have here, the diapophysis assuredly having reached its definite elevation. Again, if I am right in conjecturing that the two pieces of rib appertain to one, the sum of these characters would seem to indicate the middle of the dorsal series, as the position to be occupied by the present bones when *in situ* in the column.

Little can be said as to the specific identity of these vertebræ, but we can only compare them with those of the preceding species:—

"*P. macrospondylus*, McCoy.—Cervical vertebræ with very rugose articular surfaces to the centrum."

"*P. Sutherlandi*, McCoy.—'Trunk' vertebræ, having the centrum two and a-quarter inches long, by three and three-quarter inches wide, by two and a-half inches deep."

As regards the first of these vertebræ, they are, so far as discovered, cervical, but if the dorsal are similarly rugose, the bones now under description must be distinct. In connection with *P. Sutherlandi*, the word "trunk" would lead one to infer that dorsal vertebræ are probably meant, as distinct from cervical and caudal; if so, the measurements are quite different from those of the present specimens.

Several species have been described from the Mesozoic rocks of New Zealand by Sir R. Owen, F.R.S.,† and Sir James Hector, F.R.S.;‡ but I am unable to satisfy myself of the identity of the present specimens with any of them. Two, *P. australis*, Owen, and *P. crassicostratus*, Owen, appear to be well known. The first is distinguished by the general character of its vertebræ; and the second by the presence of a very large central tubercle. The four others we are less acquainted with, and a comparison without actual specimens becomes very difficult. Two, *P. Hoodi*, Hector, and *P. Holmesii*, Hector, are known only by cervical vertebræ; whilst of the two others, *P. Traversi*, Hector, and *P. Mackayi*, Hector, we are only acquainted with cervical vertebræ and portions of the lower jaw of the first, and general fragments of the skeleton of the second. Under these circumstances, as I am unable to make as minute comparisons as should be done, a distinctive name is not applied to the fossils now under consideration.

*Loc.* Walsh River, North Queensland (*C. W. De Vis*—Queensland Museum, Brisbane).

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\* Mon. Foss. Reptilia Lias Form., 1865, Pt. 1, p. 6.

† Report Brit. Assoc., 1861, p. 122; Geol. Mag., 1870, p. 52.

‡ Trans. N. Zealand Institute for 1873 [1874], p. 333.

## CHAPTER XXXIII.

### THE DESERT SANDSTONE FORMATION.

(UPPER CRETACEOUS.)

THIS great formation must at one time have covered at least three-fourths of the Colony of Queensland, although its denuded remains now occupy less than the twentieth part of the area over which it originally extended. After the Rolling Downs Formation had been laid down in the comparatively narrow sea which connected the Gulf of Carpentaria with the Great Australian Bight, and converted the Australian area into two islands, a considerable upheaval took place. The denudation of the Rolling Downs Formation followed, and must have gone on for some time. Unequal movements of depression then brought about lacustrine conditions on portions of the now uplifted bottom of the old deep-sea strait, and in other portions permitted of the admission of the waters of the ocean. Finally, a general upheaval placed the deposits of the period just concluded in nearly the positions in which we now find them.

In the southern portion of the Colony a good deal of the Desert Sandstone may be seen without leaving the Southern and Western Railway. It begins first to arrest the attention of the traveller to the west of Hodgson, in the low table tops of Mount Abundance, near Brinsop Railway Station (338 miles). The station is 1,170 feet above the sea, and the base of the sandstone tableland is not much above that altitude. The railway cuts through a low sandstone tableland, about the same altitude, just before reaching Amby Station, and passes to the south of another on the opposite or west bank of Amby Creek. South of Mitchell Station (1,104 feet), another sandstone tableland is passed on the north. Between Womallilla and Mungallalla Stations (400 miles) the line cuts through another tableland which stretches for a considerable distance to north and south.\* At Dulbydilla (410 miles) the line surmounts the divide between the Culgoa and Warrego Rivers, which is capped by a table of Desert Sandstone about two hundred and eighty feet in total thickness, the upper portion being red, gritty, ferruginous, and the lower portion felspathic sandstone. The base of the sandstone is only a little above the level of Dulbydilla Railway Station (1,443 feet). One standing on the top of the range near Dulbydilla, and looking north and east, can see the Desert Sandstone forming an almost continuous line of cliffs enclosing, like a frame, the heads of the Culgoa River, and prolonged eastward along the summit of the so-called "Great Dividing Range" between the Dawson and Condamine Rivers. In the sandstone at Dulbydilla—which I have had an opportunity of examining minutely†—I saw no organic remains except plant-impressions, too imperfect for identification. At 398 miles (two miles east of Mungallalla Station), a fine-grained ferruginous sandstone, red to yellow in colour, yielded a number of curious impressions, to which Mr. John Falconer directed my attention, and

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\* It is evident from the descriptions given by the late Rev. W. B. Clarke of the localities from which the Wollumbilla and Amby fossils were derived, that he had no idea that the sandstone tablelands in question were distinct from the fossiliferous (Rolling Down) beds, an idea which the late Mr. Richard Daintree was the first to entertain.

† In October, 1885, when on an expedition in search of artesian water in the Western Interior, in company with the Hydraulic Engineer.

which are in the Survey Museum awaiting the advent of somebody who can throw light upon their origin. The surface of the sandstone, which is in thin flags, is marked by a network of raised lines crossing one another at all angles. These lines are probably due to the filling up, with fine sand, of cracks produced by sun-drying, the subsequent shrinking of the rock on consolidation having left the lines standing in relief. Each square, or rectangle, or trapezoid, encloses a scroll in high relief, the outer end of which generally springs from one of the straight lines. The scrolls somewhat resemble the circinate veneration of the fronds of ferns, but the resemblance is evidently a mere fancy. My Colleague believes that the scrolls are not even of organic origin, and they form an unsolved puzzle which weighs on my mind. At this place the Desert Sandstone rises to a height of about one hundred feet above the level of the railway. The highest beds are of red sandstone. These rest on yellow sandstones, which overlie shales or mudstones, with bands of clay-band ironstone nodules. It is on the yellow sandstones that the circinate markings occur. The same beds also contained tracks and burrows, and questionable plant-remains, including fragments of silicified wood.

The railway line furnishes a convenient datum from which the altitude of the base of the Desert Sandstone can be ascertained. So far as the railway traverses the district of Maranoa—*i.e.*, from Yeulba (281 miles) to Dulbydilla (410 miles)—it rises with a gentle grade from 986 feet to 1,443 feet above the sea-level, or about six feet in a mile. The bases of the Desert Sandstone fragments seen from the railway probably average about twenty feet above the level of the rails. In other words, the present denuded surface is only a little below that on which the Desert Sandstone was laid down. The base of the Desert Sandstone may be taken to rise from 1,006 feet at Yeulba to 1,463 feet at Dulbydilla.

Over the whole Maranoa District the Desert Sandstone rests horizontally, and with a distinct unconformability, on the Rolling Downs strata, which dip to the south, and from which the Wollumbilla fossils discovered by Mr. Gordon and described by the Rev. W. B. Clarke in 1867,\* and by Mr. Charles Moore † in 1869, the fossils described by the latter gentleman from the Amby River, Mount Abundance Run, Blythesdale, and Bungeworgorai,‡ and the fossils from the Mitchell River, and Roma, collected by me in 1885, and described by my Colleague in the following pages, were collected.

My journey to the west in 1885 led me from the then terminus of the railway (Dulbydilla) to the present terminus at Charleville by coach. From Dulbydilla to Morven (nineteen miles), the soil is red and sandy, and is evidently derived from the decomposition of the Desert Sandstone, although the latter is probably *in situ* only on the very divide. An outlying table of Desert Sandstone is seen on the north side of the road. From Morven to Thurles (fifteen miles), the soil is reddish, but gradually grows greyer to the west. At Thurles (1,250 feet), the surface is strewn with pebbles of red sandstone and red ironstone, derived from the decomposition of the Desert Sandstone. A Desert Sandstone tableland lies north of the road between Hamburg and Angellalla Creeks. A large tableland, known as the Angellalla Range, lies between Angellalla and Bradley's Creeks. Its base is 1,360 feet, and its summit 1,485 feet above the sea-level. The upper beds are coarse and gritty with quartz pebbles; the lower beds are hard, white, fine-grained and felspathic, with a conchoidal fracture.

From the Angellalla Tableland to Charleville only the "Rolling Downs" strata are met with. The level of Charleville by the railway survey is nine hundred and sixty-six feet. When Mr. J. B. Henderson, Hydraulic Engineer, and I travelled

\* Quart. Journ. Geol. Soc., 1867, xxiii., p. 7.

† Loc. cit., 1870, xxvi., p. 226.

‡ Loc. cit., p. 233.

together in 1885 the Aneroid gave the level of Charleville as 1,190 feet. Although the latter reading must be wrong, it may be retained for the sake of comparison, as it was one of a series taken all along the route from Brisbane to the Grey Range. At Millie Station, on the Ward River, our Aneroid read 1,120 feet. The southern extremities of Desert Sandstone tablelands were seen to the north of the Adavale road, between the Nive and Ward Rivers, and between the Ward River and Middle Creek. The bases of these tablelands would probably be about 1,200 feet above the sea, by our reckoning.

Between Ambatalla Creek (1,190 feet) and Emu Creek (1,025 feet) the road crosses a Desert Sandstone tableland (the Paroo Range), which extends from north to south and is seven miles in breadth. The base of the sandstone is 1,080 feet and its summit 1,280 feet above the level of the sea. The difference in the vegetation of the tableland and of the surrounding "Rolling Downs" is most marked. The "Downs" are well grassed and covered in places with mulga and gidgee trees, while the Desert Sandstone has only low brushwood and is almost destitute of grass. The Paroo Range is a spur of the Warrego Range, which divides the heads of the Bulloo River from the heads of the Barcoo. Opals are said to be abundant in the range at the head of Pleasant Creek. I have been reliably informed that the northern part of the range is capped by a lava-form bed of basalt.

The Town of Adavale (1,000 feet) is built on a cemented gravel or conglomerate, apparently derived from the waste of the Desert Sandstone.

Between Adavale and Milo Station, on the Bulloo (fifteen miles north-north-west of Adavale), is a low tableland of Desert Sandstone. About two miles north of the station a spring rises from a fine-grained hardened sandstone rock (Desert Sandstone?), and even in the terrible drought which prevailed at the date of our visit gave an estimated yield of one and a-half cubic inches per second. This spring is about 1,030 feet above the sea and twenty feet above the station. At the base of the Desert Sandstone tableland, west of the station, the Manager, Mr. Beck, informed me that there are springs capable of watering four thousand sheep in the driest season. In a well in the north-west corner of Britomart Block, thirty miles west-south-west of Milo Station, a well was being made through the Desert Sandstone. The section was described by the sinker as follows:—

	Feet.
Yellow and brown sandstone [Desert Sandstone] ... ..	138
Blue-grey clay shales, with indistinct plant remains [Rolling Downs]	19
	<hr/> 157

Brackish water was met with at fifty feet; the supply is only about six hundred gallons per day.

The direct road from Adavale to Windorah, on the Thomson River, crosses the Desert Sandstone tableland in Lat. 25° 50' S. North of the road the tableland bifurcates, the western limb being known as the Cheviot Range, and the eastern limb retaining the name of the Grey Range. The public-house "Jack on the Rocks" affords a welcome to the weary bushman near the summit of the range, although rather on the Barcoo fall. A shallow well near the house collected, even in the terrible drought of 1885, sufficient soakage water from the Desert Sandstone to supply the house. Mr. Beck informed me that springs break out—(1) At the base of the sandstone at the bifurcation of the Cheviot and Grey Ranges (head of Coonabilla Creek); (2) in Oxford Downs Block, halfway up the range; (3) in the same block on the top of the range; (4) at the base of the Grey Range, near the head of Durilla Creek; and (5) round the base of an isolated tableland

between Coorajah and Spencer Creeks (between Grey and Cheviot Ranges). Two of these springs were capable of watering one hundred thousand sheep each, and another of watering twenty thousand, even in the drought of 1885.

Opals are found in the Cheviot Range, on Bulgroo Run, and in the Grey Range, on Nickavilla Run. At the latter place, Mr. Fitzwalters, of Adavale, one of the owners of the mine, informed me that the opals are found by driving into the conglomerate or sandstone cliffs, the opals being found in nodules of siliceous ironstone. Elsewhere they are found in similar nodules scattered over the surface of the Rolling Downs, and evidently derived from the waste of the Desert Sandstone. Some of the finest opals I have ever seen came from Kyabra Creek, in this neighbourhood. The "change in popular fancy" and the "eradication of prejudice" which I observed in 1886 \* were all that was required to make the Queensland opals "as valuable as the most appreciated gems from Hungary," appear to have already in some measure been brought about.

In the whole of the region described, from Dulbydilla to the Grey Range, the Desert Sandstone tablelands rest on the Rolling Downs beds at elevations varying from 1,463 feet to about 1,000 feet. The late Mr. Charles S. Wilkinson, Government Geologist of New South Wales, informed me, however, that the Palæozoic rocks of the Barrier Ranges are continued into Queensland at the southern end of the Grey Range, and it is probable that the Desert Sandstone in that locality rests directly on the Palæozoic rocks.

West of the Grey Range the Desert Sandstone forms a tableland extending from north to south for nearly one hundred and fifty miles, with a breadth varying from seven to thirty-six miles. I have not visited this outlier, but it is evident from the Runs Map, published by the Lands Department, that the rainfall soaked up by the Desert Sandstone escapes in springs around its base—that is, as soon as it comes in contact with the argillaceous rocks of the Rolling Downs Formation. The same is true of Willie's, Walter's, and Hood's, three little ranges north of Hungerford, and which are surrounded by springs.

The Desert Sandstone of the Cheviot Range, although it has been breached by the Thomson River at Windorah, is doubtless continued to the north for nearly two hundred miles by the range which divides the Diamantina waters from those of the Thomson. The south end of this range is unknown to me, but I had an opportunity in January, 1882, of seeing its northern extremity near Winton. It presents a long line of bold mural cliffs to the north, and is surrounded by outlying fragments, once a part of it, to north, south, east, and west. I visited the "Lancewood Range," between the Diamantina River and Wokingham Creek, and found it to be composed partly of gritty white sandstone and partly of hardened white clay, horizontally bedded.

In the "Opal Range," south of Winton, and in the tableland between the Diamantina and Mayne Rivers, both outliers from the long tablelands, opals are found.

Between Morven and Tambo something is again seen of the Desert Sandstone, in the spurs from the western side of the range dividing the Warrego from the Balonne waters, and of the fragments into which the range has been cut. Seven miles west of Clara Creek is a tableland of horizontal beds of fine-grained hard sandstones, with layers and bands of hardened feldspathic clay, presumably the north end of the Angellalla Range already mentioned. The beds have a total thickness of a little less than eighty feet, the road being 1,400 feet and the top of the tableland 1,480 feet above the sea-level. Several fragments of the Desert Sandstone tableland are seen to right and left of the road between Clara Creek and the township of Ellangowan, on the Warrego

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\* Handbook of Queensland Geology, p. 77.

River. The road also crosses several ridges covered with stony *débris* of the Desert Sandstone, but as a rule it keeps on the lower Rolling Downs Formation. Between Augathella and Nive Downs the road for eight miles is carried over a red sandy ridge, obviously formed from the *débris* of the Desert Sandstone, which is probably *in situ*. The road up the right bank of the Nive River shows nothing but the Rolling Downs Formation, and the divide between the heads of the Nive and Barcoo is crossed almost imperceptibly, and Tambo is reached without the Desert Sandstone being met with, although its cliffs are seen in the distance to left and right.

As the road from Tambo to Blackall follows the course of the Barcoo River below the level of the base of the Desert Sandstone, nothing of that formation is seen, but there can be no doubt the "Broken Sandstone Ridges," seen in the distance towards the heads of Dismal, Birkhead, and Windeyer Creeks, and which are laid down on the Runs Map of Mitchell District, issued by the Lands Department, are outliers of the Desert Sandstone Range, between the heads of the Barcoo and Belyando. The Runs Map of Mitchell District shows the edge of the Desert Sandstone tableland east of Aramac, and also shows distinctly how the water absorbed by the porous sandstone escapes at the edge of the tableland to form springs and waterholes (Friendly Springs, Lake Mueller—a soda lake—&c). On the Blackall and Aramac Road, between Home and Evora Creeks, the country is sandy, and the southern half of the district is covered with blocks of stone derived from the Desert Sandstone, clothed with *Spinifex* grass (*Triodia*); but the Rolling Downs strata are the rocks *in situ*. It is evident, however, that the Desert Sandstone has but recently been denuded from this locality. The crossing of the Alice near Evora Creek is 1,150 feet above the level of the sea.\*

The road from Blackall to Jericho Railway Station, which was the terminus of the Central Railway when I visited the district in November, 1885, after the first twenty-five miles up Dismal Creek, is carried through heavy sand clothed with *Triodia*, evidently the *débris* of Desert Sandstone; but it is at fifty-six miles from Blackall that the formation is first seen *in situ* at a place locally known as "The Rocks." The sandstones are hard, fine-grained, yellow, ferruginous, and micaceous. Three miles further low hills rise on the north to an elevation of 1,930 feet above the sea and 50 feet above the road. The beds of which these hills are composed dip at 3° to the west. A continuous cliff-section could not be seen. The uppermost beds are, of course, hard yellowish grit (which would make a fine building stone) with imperfect plant-impressions, and a beautiful fine-grained, hard, white, siliceous grit, with a vitrified appearance. One piece of a silicified tree which I saw lying flat on the grit was three feet long and about eight inches in diameter. The talus below the cliffs shows that among the strata are some of ironstone and conglomerate (with round milk-white quartz pebbles), although these beds are concealed by the talus. From the hill-top similar hills are seen to the north and south, all presenting their scarps to the east and dipping gently to the west. From this point to Jericho the road is heavy white sand formed from the waste of the Desert Sandstone *in situ*. Ten miles short of Jericho is a small spring on the roadside, the water standing only a foot below the surface (even in the terrible drought of 1885), and tasting strongly of lime. It is surrounded by calcareous tufa.†

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\* The Aneroid altitudes taken on this journey are given, as being at least of value relative to one another, although they are undoubtedly incorrect. The Railway Survey, for instance, makes the Barcaldine Terminus 953 feet, and this locality must be at least a little *higher* than the crossing of the Alice, where our Aneroid read 1,150 feet.

† Jericho, according to the Railway Survey, is 1,220 feet above the sea: the Aneroid made it 1,410 feet. The readings between Dulbydilla and Jericho will have to be corrected accordingly.

Stewart's Bore has been sunk for artesian water by the Government through Desert Sandstone rocks, approximately in Lat.  $24^{\circ} 20'$ , Long.  $146^{\circ} 20'$ .

The bore is situated about midway between Tambo and Alpha Railway Station, It "was completed to the contract depth of 2,000 feet, unfortunately without tapping overflowing water, and this is the first Government bore in which no overflowing artesian water has been tapped since the present system of boring was introduced in 1887. The strata pierced have been clays, shales, conglomerates, and sandstones of the Desert Sandstone or Upper Cretaceous Formation."\*

This bore is interesting and unique. All the successful bores in the Western District have obtained their supply of water from the Lower Cretaceous rocks. It is quite possible that if the bore had been continued to the base of the Desert Sandstone, water would have been met with, but it is unlikely that it would have overflowed at the surface, as the moisture with which the Desert Sandstone is generally saturated has abundant facilities for escaping (as it frequently does) at the base of the formation, where it comes in contact with the argillaceous shales of the Rolling Downs (Lower Cretaceous).

According to the Railway Survey the highest point on the divide between the Barcoo and Belyando Rivers crossed by the Central Railway is 1,448 feet. The Desert Sandstone extends past this to a few miles east of Pine Hill Station (1,158 feet—255 miles from Rockhampton), where it probably overlies the rocks of the Drummond Range (Star Formation).

This same tableland is by far the largest fragment of the Desert Sandstone which has escaped denudation, extending, as it does, from the heads of the Warrego to the heads of the Flinders, a distance of three hundred and thirty-six miles, with a breadth, on the line of the Central Railway, of seventy-two miles. Further north, where I crossed it in January, 1882, between the Thomson and Cape Rivers, its breadth is one hundred and twenty miles. Travelling from west to east,† a "jump up" of about fifty feet near the head of Jirking Creek, brought us from the Rolling Downs Formation to the top of the Desert Sandstone Tableland. The junction of the two formations is unconformable. The base of the Desert Sandstone, as seen at the "jump up," is highly ferruginous, and apparently of volcanic (ashy) origin. The immediately succeeding beds are of tough hardened sandstone, almost quartzite in places. Pebbles of the latter are scattered all over the Rolling Downs to the west. The tableland extends eastward to a line between Manoa Creek and the Campaspe River, and is so flat that to the eye it appears a dead level except where it is intersected by streams. Sections of the rock are consequently very rare. Beef-coloured sandstones and thin plates of yellow sandy ironstone were seen about eight miles below the upper crossing of Amelia Creek. The divide between the Landsborough and Burdekin waters, although marked on the Colony Map as a continuous mountain chain, is imperceptible. A great part of the tableland is thickly timbered with rather stunted ironbark, bloodwood, box, and gum, and grassed with *Triodia*. Near the Campaspe mica schists are met with, but there is nothing to show whether the Desert Sandstone rests unconformably on these, or is faulted against them. The former is more probable.

The same tableland is crossed by the Northern Railway from the one hundred and twenty-three-mile peg (say 1,100 feet above sea-level) to about two hundred and twenty-four miles (say 1,169 feet). At one hundred and sixty-two miles yellow, brown, and white sandstones are quarried for building material, which is employed,

\* Report of the Hydraulic Engineer for Year ending 30th June, 1889. Brisbane: by Authority: 1889.

† See Reports on the Geological Features of part of the District to be traversed by the proposed Transcontinental Railway. By R. L. Jack. Brisbane: by Authority: 1885.



e.g., in the foundation course of the Cathedral at Townsville. The level of the surface of the Desert Sandstone at Burra (one hundred and sixty-nine miles) is 1,817 feet. From Coalbrook Railway Station (one hundred and ninety-five miles from Townsville—say 1,423 feet) I crossed the Desert Sandstone in January, 1888,\* on a course of N. 29° W. for a distance of eighteen miles to the Flinders. The country was flat and tame. Almost from the left bank of the Flinders the waters drain through open marshy plains and lightly timbered forest country southward into Bullock Creek, one of the feeders of Cooper's Creek. The divide between the Gulf waters and those of the Great Australian Bight is thus crossed imperceptibly, although on the Colony Map it is denoted by shading indicative of a chain of mountains. The Desert Sandstone is covered by a more recent deposit of weathered, and in part water-arranged material derived from its waste, and cemented together with peroxide of iron and carbonate of lime. The soil derived from the latter deposit, it may be noticed, bears better grass than is usual in Desert Sandstone country. A good part of the district is fair pastoral land, with frequent patches of blue grass and only rare clumps of *Triodia*. On the left bank of the Flinders the Desert Sandstone, with a total thickness of about twenty feet, rests unconformably on Rolling Downs strata, including some coal-seams. The Desert Sandstone here consists of thin, almost flaggy, beds of yellow and white siliceous material, sometimes gritty and occasionally pebbly, the pebbles being invariably of white quartz. The bedding-planes and joints of the sandstone are frequently coated with films or layers, up to one-eighth of an inch in thickness, of binocide of manganese.

The thinning out of the sandstones of the great tableland is again well exemplified on the head of the Flinders River,† where I saw it in September, 1881. I may observe that I started on this journey with a broken collar-bone, and was consequently unable to do much climbing. The granite range dividing the Burdekin from the Flinders is crossed by the Dalrymple and Hughenden Road, at an elevation of 3,040 feet (by Aneroid), and is flanked by a deposit of basaltic lava, disposed in nearly horizontal beds and extending to Dalrymple on the east, and to Tatoo Camp, seven miles above Wongalee Station, on the west. At Tatoo Camp a gully cuts through the lowest bed of basalt and exposes about fifty feet of the underlying Desert Sandstone. The sandstone is white or yellowish, with false-bedding, and with soft ferruginous portions, apt to weather into caverns. The only fossils observed were some twig-impressions. *Triodia* at once takes possession of the soil where the Desert Sandstone comes to the surface. It occupies, however, at this place, only a narrow belt of country. The basalt occurs in outlying table-mountains between Porcupine Creek and the Flinders, as far as Mount Beckford, where it rests on the Desert Sandstone at an elevation (by Aneroid) of 1,800 feet.

The Section (Plate 45, fig. 1) shows the relation of the Desert Sandstone and basalt between the Burdekin and the Flinders.

The Runs Map of Mitchell District shows about a score of little isolated tablelands, which are outliers from the large tableland above described, and attest the former extension of the Desert Sandstone to the west, although at slightly lower levels than that of the base of the main tableland. The Desert Sandstone undoubtedly covered the whole Mitchell District, and the present surface of the Rolling Downs over the whole district is only a little lower than that on which the Desert Sandstone was deposited.

\* Report by R. L. Jack., On Coal Discoveries on the Flinders. Brisbane: by Authority: 1888.

† See Transcontinental Railway Report. By R. L. Jack. 1885.

Outliers of Desert Sandstone were seen to the north of the Flinders, opposite Telemou (forty miles west of Hughenden), while I was travelling over the Rolling Downs in 1881.

In reporting on the Cape River Diggings in 1868, Mr. Daintree wrote as follows:—

"The stratified rocks which rest uncomformably on the auriferous slates to the south-west, and so cut off the extension of gold-mining in that direction, are those which form that barren desolation, locally called the 'Desert,' from which the eastern tributaries of the Thomson and Flinders Rivers take their rise.

"The upper beds of this series are coarse friable sandstones, supported by thick-bedded conglomerates, underlaid in turn by white clays and shales, with interstratified layers of carbonaceous matter, but no true coal was observed. Where these conglomerates are seen resting on the mica-slates, as is frequently the case in the upper branches of Rankin's Mistake Creek, the gullies have been worked, and payable gold obtained where this conglomerate forms the bottom, and its broken-up fragments, the 'wash-dirt'; but as no attempt has been made to sink through the cement (though here very thin) the question of whether gold exists as a product of denudation of the old schist rocks, at this early period in the world's history, yet remains uncertain.

"Conglomerates and sandstones of the same lithological character, and occupying the same relative position in regard to the auriferous slates, were tested practically by the Geological Survey of Victoria, in the Bacchus Marsh District, without finding the 'colour' of gold; here, however, is renewed encouragement to re-investigate the matter, as the miners in Conglomerate Gully found *water-worn gold attached to small pieces of cement*, together with free gold."\*

In 1890 Mr. Rands made a discovery which will revolutionise our ideas of the value of the fossil *Glossopteris* in determining the horizon of the rocks in which it is found. The following quotation is from his Report on the Cape Gold Field†:—

"Following up Betts' Creek, to within about a mile of Conglomerate Gully, high banks of sandstone and shale are seen to the southern side of the creek. The sandstone at the base is fifteen feet thick. It is a coarse white sandstone, with layers of quartz pebbles in it, like that generally met with in the Desert Sandstone rocks. Above this there is a layer of shale, and then alternate white and brown mud rocks. Above these is a bed of sandstone, and then a thin bed of shale full of *Glossopteris* leaves. Above this again is sandstone. The height of the bank is forty feet. The beds are almost horizontal. I fortunately had an opportunity of submitting these fossils to Mr. R. Etheridge, junr., who pronounced them to be undoubtedly *Glossopteris*. From the character of these beds, and also from the stratigraphical position of similar beds, seen in the railway cuttings on the range beyond Pentland towards Hughenden, where they certainly overlie the Rolling Downs Formation, I would pronounce them to be Desert Sandstone.

"If this be the case, however, then the plant *Glossopteris* must have a much longer range in time than has hitherto been suspected, as it was supposed to be confined to the Palæozoic rocks, or at most to range as high as the Lower Mesozoic. Mr. Etheridge has determined the supposed *Glossopteris* of the Burrum Coal Field and of Stewart's Creek, near Rockhampton, to be a form of *Taniopteris*.‡ . . .

\* Report on the Cape River Diggings and the latest Mineral Discoveries in Northern Queensland. By Richard Daintree. Brisbane: by Authority: 1868.

† Brisbane: by Authority: 1891, p. 10.

‡ *Phyllopteris*. (R.E. Junr.)

"At the mouth of Oxley Creek bold cliffs of white sandstone occur which extend away in an east-south-easterly direction. The cliffs here are about three hundred feet in height.

"In the bed of White Mountain Creek, opposite the mouth of Oxley Creek, there is a bed of brown shale in which the plant *Calamites*\* occurs in great numbers. Above the shale the rock consists almost entirely of coarse white sandstone, with layers of quartz pebbles, and also thin beds of shale and conglomerate. *Calamites* occurs again in an iron-stained sandstone higher up the cliff. Near the junction with the schists these beds are dipping S.W. at 25°, but further in they are horizontal.

"These beds extend away down to Betts' Creek, crossing the railway line at the range. They can be seen as far as eye can reach from Mount Black and the range behind Mount Black.

"White Mountain Creek has cut a deep channel through the sandstone from Oxley Creek to its junction with the Walker or Flinders River, a distance of about three and a-half miles.

"Following up Walker River, the stream has cut a somewhat narrow channel or cañon, two hundred feet in depth, through the Desert Sandstone and the basalt which here overlies it. The Desert Sandstone consists of a coarse, thick-bedded sandstone, with layers of quartz pebbles, beds of conglomerate, and thin beds of shale. The sandstone shows false-bedding in parts. The overlying basalt is about 50 feet in thickness.

"About two and a-half to three miles up the river from the junction of White Mountain Creek, the Desert Sandstone is seen faulted against the schists by a fault running east-south-east and dipping south-south-west. The schists and Desert Sandstone are both covered with basalt. The Desert Sandstone is bent up near the fault, and is dipping south-south-west. The section is well seen in the bank of the river."

Mr. Rands' observations on this point seemed of so much importance that in July, 1891, I visited the scene of his discovery with the view of settling whether the beds in which he found *Glossopteris* really belonged to the Desert Sandstone.

About a mile south-west of the junction of Paddy's Gully with Running Creek, I struck Betts' Creek, which I traversed for a little over a mile to its junction with Conglomerate Gully. The latter I identified from the description on page 10 of Mr. Rands' Report on the Cape, of a section of sandstones and shale. I ran up Betts' Creek for about a mile further, and then returning to where I had first struck the creek, rode down the creek to the crossing of the old road and telegraph line from Capeville to Hughenden. Nearly horizontal conglomerate sandstones and shales were met with on both sides of Betts' Creek for the greater part of the distance. I was not fortunate enough to find the "thin bed of shale full of *Glossopteris* leaves" referred to by Mr. Rands, although in several beds of shale I could see indistinct and fragmentary plant-remains, and the sandstones occasionally retained impressions of large limbs or trunks of trees.

The sandstone rocks are traversed by the Northern Railway Line from the 152½-mile peg (from Townsville) to the 215-mile peg. At the former they overlie the auriferous schists of the Cape Gold Field, and at the latter they overlie the shales of the Rolling Downs or Lower Cretaceous Formation. in both cases unconformably. On the Flinders, as described elsewhere, they overlie the coal-bearing Lower Cretaceous rocks. There can be no doubt of the continuity of the Desert Sandstone over this immense area, and it must be accepted as an established fact that *Glossopteris*, which is abundant

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\* Probably *Equisetum*. (R.E. Junr.)

in the Permo-Carboniferous Coal Measures, re-appears in the Desert Sandstone. As yet its presence has not been detected in the *Teniopteris*-bearing Burrum Beds, nor in the *Teniopteris*-bearing Ipswich Beds, nor in the Lower Cretaceous Rolling Downs Formation. Whether its absence from these formations is simply due to imperfect collecting, or whether the plant really migrated from the Australian Region after Permian times, to re-appear at the close of Mesozoic times, there is no evidence to show. It may any day be found in the lower members of the Mesozoic Period. A long controversy was carried on as to the age of the *Glossopteris*-bearing beds, the late Rev. W. B. Clarke and Mr. Daintree insisting that the plant was Palæozoic—a view which received confirmation when it was found on the Bowen River, together with *Productus*, *Spirifer*, and other Palæozoic fossils of the Lower or Marine Series of the Bowen River Coal Field; while Professor McCoy restricted the plant to the Mesozoic formations. It has been generally understood that the question had been settled triumphantly in favour of Mr. Clarke's view, but we must now admit that *Glossopteris* also, as a genus, existed in Permo-Carboniferous times, and survived till the close of the Mesozoic Period. *Glossopteris* occurs in India in Jurassic beds, and it may for some unknown reason have migrated to that country during the period in which it has been missed from Australian formations.

Mr. Rands' discovery leaves no further room for doubt as to the correctness of the observation of Mr. Norman Taylor, who refers to *Glossopteris* in the sandstone tablelands between the Mitchell and the Walsh, as will be subsequently mentioned—an observation which I was inclined to explain away by some theory of the Desert Sandstone of that region being a distinct formation from that in which *Glossopteris* was found to occur. I believed that the section must be something like that seen on Oaky Creek and the Normanby and Little Kennedy Rivers in the Cooktown District, where the Desert Sandstone rests unconformably on the upturned edges of *Glossopteris*-bearing strata. Mr. Taylor, naturally, considering the views accepted at the time regarding the age of *Glossopteris*, mapped the tableland in question as Carboniferous; but there can no longer be any difficulty in recognising it as belonging to the Desert Sandstone, of which it is evidently a denuded fragment.

Mount Nicholson, on the west side of the Cloncurry River, about four miles north of the Township of Cloncurry, is a tableland which, as seen from any point of the compass, shows unmistakably a horizontal capping of stratified rocks resting on older rocks. I found (in September, 1881) the slopes to be of a decomposed gneissose rock, and the top\* had a thickness of twenty feet of coarse, gritty, siliceous sandstone, occasionally pebbly (the pebbles mainly of white quartz), horizontally bedded. The sandstone was "baked" throughout, and in parts might be fairly described as a quartzite.

Up the Cloncurry the "Soldier's Cap" and two other small tablelands show cappings of horizontal Desert Sandstone resting on slate.

Two outliers of horizontal Desert Sandstone rest on upturned slate and quartzite rocks near the head of Cabbage-tree Creek, a tributary of the Leichhardt.

The late Mr. Richard Daintree refers† to the Desert Sandstone as extending from Donor's Hills on the north to the Dugald River on the south (left bank of Cloncurry River). "Again, on the same parallel, between the Norman and Gilbert, two degrees of longitude could be passed over without seeing any but the 'Desert Rocks' exposed, except in the deeper valleys." The rocks here referred to come down to not very far above the sea-level.

\* About 1,200 feet above the sea-level, but my Aneroid had become unreliable.

† General Report upon the Northern District. By Richard Daintree, Esquire, late Government Geologist for Northern Queensland. Brisbane: by Authority: 1870.

Mr. (now the Honble.) W. O. Hodgkinson, in his "Diary of the North-Western Expedition, 1876,"\* refers to Desert Sandstone capping slates at the head of the Templeton.

Mr. A. C. Gregory, in travelling down the Nicholson in August, 1856,† noted near the head of that river "country consisting of steep sandstone ridges covered with *Triodia* and a few stunted eucalypti," leaving little doubt that the Desert Sandstone fragments extend to the extreme western boundary of the Colony. In fact, Mr. Gregory, who among Australian Explorers, stands conspicuous for accuracy and power of observation, had no hesitation in recognising the Desert Sandstone far to the west of these limits.

On the divide between the Burdekin and the Lynd, in Lat. 18° 50' S., a low tableland of ferruginous Desert Sandstone is seen on the north side of the Townsville and Etheridge Road. The sandstone rests directly on granite. On the same road, near Doughboy Creek, sixteen miles south-east of Grey's Creek, are cliffs of about fifty feet in height, of soft, red, ferruginous sandstones and conglomerates, the pebbles of the latter being mainly of the brown and yellow Devonian Sandstones. The cliffs are the edge of a tableland of Desert Sandstone, which extends south-westward nearly to the Broken River. Other fragments of the Desert Sandstone are seen to right and left of the road a few miles west of the "Continong" Gold Mine.

In his Report on the "Geology and Mineral Resources of the Upper Burdekin,"‡ Mr. Maitland describes, as follows, certain stratified rocks in the valley of the Burdekin:—

"Throughout the district, at all elevations, there occur isolated fragments of reddish-coloured sandstones and conglomerates, which are provisionally regarded as being of Desert Sandstone age. Nowhere were they found to contain any fossils, nor was there any great thickness of them visible in one section.

"The first exposure of these rocks is met with in the country drained by the heads of Oakey Creek, at an altitude of about 2,300 feet above the level of the sea. Here the rock consists of an angular quartzose grit, which further south passes into a brecciated conglomerate.

"Lower down the creek, near its junction with the Burdekin, a series of well-nigh horizontal conglomerates and grits is crossed by the track from Kangaroo Hills Station to Donnybrook; a conspicuous escarpment of a higher member of the series can be traced by the eye for a considerable distance east and west.

"Near the head of one of the branches of the Douglas River a similar series of angular grits and conglomerates is seen to overlies the granite. The area occupied by these rocks is small.

"The road from the crossing of the Burdekin, near Greenvale Station, to the Valley of Lagoons, is flanked on its western side with tables of red sandstone, which doubtless belong to the Desert Sandstone system. In the vicinity of the Valley of Lagoons Station these rocks form well-marked escarpments, running up to the heads of minor gullies, which empty themselves into the lagoons with which the eastern bank of the Burdekin is studded. In one place these rocks are seen to consist of brecciated conglomerates made up of large sub-angular fragments of quartz and mica-schist set in a reddish-brown sandy matrix. These rest upon the upturned edges of the quartzites, schists, &c.

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\* Brisbane: by Authority.

† Journals of Australian Explorations—by A. C. Gregory and F. T. Gregory. Brisbane: James C. Beal, Government Printer: 1884, p. 169.

‡ Brisbane: by Authority: 1891.

"A creek entering the Burdekin from the west exposes in a cliff on its northern bank a bed of conglomerate similar to that above described, resting upon schists, and covered by a compact basalt sheet.

"The divide between the Herbert and Burdekin is capped by horizontal beds of friable ferruginous sandstone, derived apparently from the denudation of granitic rocks; these rest alternately upon acidic lavas and granite.

"In Blackwater Creek, a tributary of the Burdekin, what are taken to be representatives of the Desert Sandstone make their appearance on either bank of the river, and are seen to rest upon granite. From this section it appears that the Desert Sandstone beds were laid down in the already denuded Burdekin Valley.

"Coarse ferruginous conglomerates or breccias, in the more immediate vicinity of Wairuna Station, rest upon the vertical edges of the slates, &c, which make up a large portion of the neighbourhood. On the south side of the Burdekin, between Wairuna and Lake Lucy, these Desert Sandstone rocks are well developed; they often form conspicuous cliffs, of no great height, which can be followed by the eye for some distance.

"The bridle-road from Wairuna to Lake Lucy crosses a tableland of ferruginous sandstone for about four miles in a southerly direction. The southern face of this is made up of a very red ferruginous grit, the material cementing the quartz grains being an earthy hæmatite.

"From Oakhill Station to the summit of the Main Coast Range several exposures of ferruginous sandstones are met with on either side of the road. These present a considerable lithological resemblance to those beds which cap the Main Range in the vicinity of the Kangaroo Hills Tin Field.

"The occurrence of fragments of these Cretaceous rocks throughout the whole of the Upper Burdekin seems to indicate that they originally occupied a very extensive tract of country. That their thickness must have been considerable is evidenced by the fact that their base occurs at all elevations above the sea-level. Taking the lowest elevation (near the mouth of Oakey Creek) at which these beds are met with as being 1,300 feet, and the highest elevation of their base [?] as being 2,200 feet above the sea, there cannot have been less than nine hundred feet of them; how much more it is at present impossible to give any idea."

A "Geological Sketch Map of the Upper Gilbert" was published in 1869 by Mr. Daintree. This map gives a very graphic idea of the relation of the Desert Sandstone to the older rocks, but as the topography of the map on which the geological lines were laid down was very inaccurate, it must be regarded rather as a diagram than as a delineation of the facts of the case. It shows correctly the Desert Sandstone resting unconformably on older rocks, such as granite, porphyry, mica-schist, slate, &c., on the summit of the Newcastle Range, forming the tableland between Gilberton and the Woolgar, and extending in isolated denuded tables over the high lands intersected by the Gilbert, Robertson, and Percy Rivers, and Agate, Cave, and other creeks. As, however, I found, on travelling over the country in 1889, that many of Daintree's names have not passed into general use, and that owing to the inaccuracies of the map on which he laid down his work his localities often could not be identified, I shall content myself with recording some of the observations recently made by myself in this region.

The Delaney River, a large tributary of the Etheridge, into which it empties itself at Georgetown, splits up near its head into Delaney Creek, Goldsmith's Creek, Caledonian Creek, and others. These creeks rise on the edge of a tableland of Desert Sandstone, denuded into numerous fragments partly covering the gneisses, schists, slates, and granites which form the groundwork of the high lands between the Robertson

and the Etheridge waters. Two miles west of the confluence of Goldsmith's and Caledonian Creeks a tableland, known as "Goldsmith's Flat-top," rests on granite. A similar tableland occurs a mile or so to the north. "The Castle" is a tableland having an area of about a quarter of an acre, three miles to the west of "Goldsmith's Flat-top," showing a thickness of about thirty feet of white pebbly sandstone or conglomerate, the pebbles being of quartz. It rests on granite, on the highest ground in the neighbourhood. From this summit "Mount Flat-top" and another Desert Sandstone tableland can be seen about twelve miles to the west, near the head of Western Creek, a tributary of the Gilbert.

About four miles north of Goldsmith's Township a long tableland of Desert Sandstone, on the high lands between Goldsmith's Creek and the Sandy Etheridge, is crossed by the direct road from Goldsmith's to Townsville.

The broken fragments of the Desert Sandstone tableland on the divide between the head of Goldsmith's Creek and the Robertson River, rise to an elevation of about 2,200 feet above the sea, while the base of the sandstone rests, at 2,110 feet (by Aneroid), on schists and slates.

On the Robertson waters, about two miles south of the divide between the Robertson and Goldsmith's Creek, a lofty bluff of bedded trachyte lava rests directly on a coarse volcanic ash, which passes in places into a conglomerate. Pl. 50, fig. 3, is a section explanatory of the supposed structure of this region. The volcanic ash and overlying bedded trachyte are probably contemporaneous with the altered ashes of the Newcastle Range. Although the trachyte and ash have not been observed in the district actually in contact with the Desert Sandstone, it is likely enough that it dates from the earlier part of the same period. Between Mount Hogan and Gilberton, on Chance Creek, a mass of coarse volcanic ash occurs, resting on slates and schists. The alteration which the ash has undergone is greater than that of the Robertson and less than that of the Newcastle Range, but I think it represents a contemporaneous deposit. The section of the ash and trachyte is very much like some of those observed by Mr. Maitland in the Mackay District, afterwards referred to.

Twenty-four miles south of the head of Caledonian Creek, the track from Goldsmith's to the Homeward Bound Mining Camp on the Percy River, after crossing the Robertson and running up McCoy's Creek to its source, goes through a gap on the divide between the Robertson and Percy waters, fifteen miles north of the Homeward Bound Camp. To east and west of the gap are cliffs of Desert Sandstone—white, cross-bedded, siliceous, pebbly grits, the pebbles being of quartz and slate. Considering that the sandstone rests directly on grey granite, the absence of granite pebbles (for which I searched in vain) is very remarkable. I saw one agate pebble, and ferruginous siliceous concretions very like those which form the matrix of the opal in the west. The sandstone is in one bed about thirty feet thick. In other places a higher bed of about the same thickness is seen. The base of the sandstone (by Aneroid) is 2,135 feet above the sea-level.

The track from Charleston, *via* Tweedside, to the Homeward Bound Camp on the Percy, about three miles north of the Percy, passes over a gap in granite country, between two walls of conglomerate belonging to the Desert Sandstone series. The base of the conglomerate is 2,240 feet above the sea. The same conglomerate is seen capping the hills between Agate Creek and the Percy, to right and left of the road. Between the Percy and Mount Hogan Creek the Desert Sandstone is seen capping the granite on the divide for six miles to right and left of the track.

Mount Nation, a conspicuous hill of Desert Sandstone, is on the right bank of the Gilbert River, about two miles above Commissioner's Hill. The hill consists of

a single bed of coarse, gritty, sharp, white sandstone, about thirty feet thick, containing imperfect plant-remains. The sandstone rests on slates and quartzites of the same age as the goldfield at Commissioner's Hill.

From Mount Nation, cliffs of the Desert Sandstone can be seen on the horizon to the south and west, the edges of tablelands dividing the Gilbert from the Woolgar and Norman.

In crossing the Newcastle Range, between Carpentaria Downs and the "Stony Etheridge," the summit for about five miles is a tableland of soft yellow Desert Sandstone. It rests on a thickness of about five hundred feet of a clastic rock, resembling a felspar porphyry, which in its turn lies on gneiss and mica schist. The Desert Sandstone is nearly horizontal, but has a very slight dip to the west.

Some twenty-five miles further north, where the same range is crossed by the telegraph line and road from Herberton to Georgetown, the road passes over a similar clastic rock, on which, at an elevation of about 2,150 feet, by Aneroid, is an outlying tableland of Desert Sandstone.

Down the right bank of the Etheridge River, below Georgetown, Mr. A. Gibb Maitland, Assistant Geologist, noted in 1889, "at the head of Conglomerate Creek, a tributary of Lane's Creek, a tableland of Desert Sandstone, the beds forming which lie horizontally. The rocks are very coarse-grained, *quasi-vitreous* grits and fine conglomerates, the base of which is, by Aneroid, one hundred feet above the town of Georgetown."\* The latter is by Aneroid measurement 1,200 feet above sea-level. The sandstone rests on quartzites, shales, and diorites very much resembling the rocks prevalent on Commissioner's Hill, Gilberton.

Down the Gilbert River, below Crooked Creek, the Desert Sandstone occurs at a level probably one thousand feet lower than at the heads of the river. At one point seven miles down the river from Crooked Creek, and two miles to the west, a small isolated hill had the following cliff-section:—

	Feet.
Yellow, brown, and white sandstone ... ..	50
Hard, brown, ferruginous, and siliceous sandstone, in part <i>quasi-vitreous</i> ...	2
Soft, fine-grained, white sandstone ... ..	15
Brown and yellow siliceous grit ... ..	15
Granite <i>débris</i> , not waterworn ... ..	6
Total ... ..	88

These beds rested on granite, about one hundred and thirty feet above the level of the Gilbert River. Smaller Desert Sandstone hills could be seen about three miles to the south, and extending from north to north-east, at a distance of about five miles from the river.

A mile west of O'Brien's Station, on the Georgetown and Croydon Road, sandstones and conglomerates of the Desert Sandstone Series are seen on both sides of the road, and nearly at the level of the road. The road and telegraph line, a little further west, get upon a low Desert Sandstone tableland, over which they are carried as far as the Gilbert River Telegraph Station. The road, after crossing the Gilbert River at the telegraph station, traverses Desert Sandstone for five miles and a-half. Some porphyry ridges are next crossed over, rising to a height of perhaps one hundred feet above the level of the Desert Sandstone. Three miles further a red bluff, and a mile further a white bluff of Desert Sandstone, are seen on the south side of the road. After crossing the Little River, the road rounds a cliff of Desert Sandstone on the south, and another is

\* Report on the Lane's Creek Diggings. Brisbane: by Authority: 1890.



seen at some distance to the north. Four miles short of Flanagan's or "The Springs" Camp, the divide between the Gilbert and Norman waters is crossed. This watershed, although marked on the Colony Map as the prolongation of the Gregory Range, is a quite insignificant elevation, composed of gritty Desert Sandstone, resting on granite and porphyry, at probably less than seven hundred feet above the sea-level.\*

Opposite Flanagan's, the eastmost camp on the Croydon Gold Field, are "The Springs." These well out with a volume which supplies a five-head battery at the base of a cliff of about thirty feet of Desert Sandstone, which rests on granite about one hundred feet above the camp. This sandstone is plentifully charged with impressions of marine Mollusca.

The same tableland extends for about three miles to the south-west to the "Alluvial Springs" (near Goldfield Homestead Area No. 120), and how much further I do not know. The springs amply supply a vegetable garden below the cliffs, owned by a Croydon Company. A little alluvial gold is found in gullies draining from the sandstone tablelands near the "Alluvial Springs."

About one mile north-east of the King of Croydon Claim, the "Richmond" auriferous reef occurs in granite country, and its cap is covered by a horizontal cake of Desert Sandstone, at a level of about one hundred feet above the surrounding flat country. The lowest bed is a very coarse conglomerate, about twenty feet in thickness, and above it is a thin bed of *quasi*-vitrified sandstone with indistinct plant-remains.

On the divide between Belmore and Cork-tree Creeks, about two and a-half miles east of Croydon Township, the "Connaught Ranger" and another auriferous reef, in a country rock of semi-vitreous quartz porphyry, are capped by a cake of Desert Sandstone named Mount Angus, consisting of two beds, the upper of *quasi*-vitrified white sandstone with plant-remains, and the lower of yellowish gritty sandstone with molluscan fossils.

North of Belmore Creek, above the mouth of the Mountain Maid Creek, there are three small outliers of Desert Sandstone. These, especially the two easternmost ones, contain plentiful but imperfect impressions of jointed bamboo-like plants. I was informed that ferns have been obtained from the westernmost of the three, and searched for them, but without success.

The summit of the ridge between the Queen of Croydon Reef and the Pioneer Machine on Belmore Creek is capped by sixty feet of horizontal white sandstone (De Vis Hill). In this sandstone, which is in part *quasi*-vitreous, I saw some impressions of Pelecypoda, which, however, were not in sufficiently good order to be worth collecting, and impressions of branches of trees up to four feet in length.

The True Blue Reef, in granite country, north of Croydon, is worked up to the base of the Desert Sandstone. At the Prospecting Claim there are only a few feet of sandstone on the cap of the reef, while on the "Numbers," to the south-east, the sandstone rapidly deepens. The diagram section (Pl. 45, fig. 2) from north-west to south-east across the True Blue Hill shows the relation of the Desert Sandstone to the granite. It will be observed that the beds of the former *overlap*. The uppermost bed is *quasi*-vitreous, and contains twig-impressions and ferns, viz.—*Didymosorus* (?) *gleichenoides*, Old. and Mor., var.† I received from Mr. Spencer, Manager of the Queensland National Bank at Croydon, some handsome specimens of this fern, now in the Geological Survey Museum.

\* Geological Observations in the North of Queensland, 1886-7. By R. L. Jack. Brisbane: by Authority: 1887.

† R. Etheridge, Junr., Additions to the Fossil Flora of Eastern Australia. *Proc. Linn. Soc. N. S. Wales*, iii. (2), Pl. 38, fig. 3.

The beds beneath are of white gritty sandstone with a few quartz pebbles, which have yielded several species of Pelecypoda, &c.

The upper level in the "True Blue No. 2 South" Claim shows that the sandstone is locally faulted against the granite as in the section (Plate 45, fig. 3).

A series of shafts sunk to the south-east of the hill in search of the True Blue Reef, commencing below the level of the lowest bed of sandstone seen on the hill, shows that a thickness of from thirty to sixty feet of white sand rarely consolidated to sandstone, underlies the strata seen on the summit of the hill, and rests on granite. But for the sections laid bare by these shafts the heavy sandy country south and east of the True Blue Hill, and connecting it with De Vis Hill to the north-east, would certainly be taken as mere *débris* washed from the hill. Some of the Southern areas therefore, already described as covered with sandy "*débris* of the Desert Sandstone tablelands," may represent the formation actually *in situ*.

By the Railway Survey Croydon is three hundred and sixty-one feet above the sea-level, just on the edge of the sandy country. The base of the Desert Sandstone, therefore, has come down from 2,240 feet at the heads of the Percy, to three hundred and sixty feet at Croydon.

From a few miles north of Croydon to Normanton, the road passes over a dreary expanse of low, level, sandy country, which falls indeed towards Normanton, although the grade is too gentle to be detected by the eye. In all probability the greater part of this district is covered by Desert Sandstone, although it is devoid of sections throwing any direct light on its structure, or at least none were to be seen when I travelled over it in December, 1889, the whole country being almost one sheet of water. The precisely similar country to the east of Normanton is described by Daintree\* as covered, over two degrees of latitude, from the Norman to the Gilbert, by Desert Sandstone.

In a Report by Mr. A. Gibb Maitland, "On the Geological Features of the Environs of Normanton,"† the Desert Sandstone Rocks of that neighbourhood are thus described:—

"Apart from the superficial deposits, the beds of the Desert Sandstone Series occupy by far the greater portion of the surface of the district. In the absence of any trustworthy data it is impossible to give any idea of their thickness. A variable thickness of concretionary ferruginous sandstone, not unlike a conglomerate in appearance, forms the upper portion of the series. Beneath this lie clayey sandstones, red, brown, and even white in colour, which pass in places into rocks possessing all the characters of true clays. In the well-sections seen within the municipal boundary, these sandstones are associated with clay shales and true clay beds, often lenticular in shape and of no great horizontal extent, and which in colour are generally yellowish-white. A bore put down in 1885 by the Carpentaria Divisional Board at the junction of Thompson and Woodward Streets, within the municipal boundary, shows 'ironstone rock,' 'mild rock,' sandstone, and clay to a depth of two hundred and twenty-four feet. The height of the surface of the bore is thirty-seven feet above high-water mark. It is greatly to be regretted that no samples of the material passed through have been kept, more particularly the 'very hard rock' met with when it was decided that boring operations should cease. From an examination of the record and from what is actually seen in the well-sections, the whole thickness of rocks is provisionally classed with the Desert Sandstone. It is, however, probable that what are described as 'clays' are not all true clays, but merely sandstones and shales containing a high percentage of argillaceous matter.

\* General Report upon the Northern District. Brisbane: by Authority: 1870.

† Brisbane: by Authority: 1890.

"On the western side of the ridge upon which the Hospital now stands, a quarry has been opened. The rock quarried is a very ferruginous fine-grained argillaceous sandstone; but the percentage of clayey matter is not so high as in the beds more immediately above. Beneath this, now covered by water, lies a bed of fairly porous reddish sandstone, the thickness of which has as yet been undetermined. The escarpment of these beds can be easily traced round to a point on the western bank of the Norman, within six yards of the bank of the river.

"Similar sections are seen in a conspicuous cliff which can be traced along the Cloncurry road as far as the Four-mile Creek, and also at intervals along the Burketown Road, near Selection 72.

"At the Red Bluff, twenty miles north-west of Normanton, and on the western bank of the Norman River, a tableland of Desert Sandstone identical in physical characters with that forming the rest of the district occurs. Its summit is sixteen feet above high-water mark, and nowhere is the lower portion seen, being concealed beneath superficial accumulations, which here attain a considerable thickness.

"A very thin capping of the concretionary sandstone of Desert Sandstone age overlies the 'Rolling Downs' formation, on a ridge about ninety feet above the sea, at Magowra Station, between the Bynoe and Norman Rivers."

The Stokes Range, to the north of Magowra, is a tableland of Desert Sandstone rising to ninety or a hundred feet above sea-level. The Reap Hook Range, further to the south, is a similar Desert Sandstone tableland. The poverty in nomenclature which applies the epithet of "range" to such elevations may be noticed in passing.

In the Cape York Peninsula the Desert Sandstone is well developed. It is most conspicuous at Mount Mulligan, on the left bank of the Hodgkinson River, where it rests unconformably on the vertical greywackes and shales of the Hodgkinson Gold Field. As seen to the west of Woodville, the lowest bed is a coarse conglomerate, with a grey matrix of granite *débris*. The pebbles of this conglomerate are mostly of quartz and quartzite, with a few of porphyry and granite. Some are of hardened greywacke and a few of hardened shale. The conglomerate is about sixty feet in thickness, and contains occasional partings of red shale or laminated mud. The next succeeding bed is of red sandstone, and forms mural precipices one hundred and fifty feet high, without a single practicable gap in a distance of ten or twelve miles. The Mount Mulligan Plateau, a few years ago, was one of the strongholds of the Aboriginal population.\* From the summit, the Desert Sandstone can be seen in isolated tablelands stretching far to the west. Mount Mulligan is probably about 1,900 feet above the level of the sea, while the greywackes and shales of the Hodgkinson Gold Field rise in the range between Thornborough and Kingsborough, to an elevation of 2,530 feet. This range must have formed part of the shore of the waters in which the Desert Sandstone was deposited. The late Rev. J. E. Tenison Woods gives the thickness of the sandstone beds of Mount Mulligan as six hundred feet,† which is obviously an over-estimate.

From the head of Limestone Creek, a tributary of the Mitchell, south of Maytown, I saw, in 1857, that some of the low hills south of the Mitchell were capped by horizontal beds of stratified rock, probably the continuation of Mount Mulligan. This is the place referred to by Mr. Norman Taylor, the Geologist who accompanied Hann's Expedition in 1872, who has kindly placed his notes at my disposal:—

"At Camp XVI., on the Mitchell River, which was also Camp LXXVIII. on our return journey, I found in the river-bed fragments and blocks of coal shales, with thin

\* Report on the Hodgkinson Gold Field. By R. L. Jack. Brisbane: by Authority: 1884.

† The Hodgkinson Gold Field, Northern Queensland. *Trans. R. Soc. Vict.*, 1881, xvii., p. 1.

seams of coal, and on searching carefully I discovered pieces of a whitish indurated shale, containing indistinct plant-remains, and an undoubted fragment of *Glossopteris*. (The shales are identical with some in the Blue Mountains of New South Wales, north of Wallerawang, and again at Tallawang, north of Gulgong.) About a mile south of this camp is a low table-topped rise, consisting of horizontal white and grey shales, and a cherty-looking rock with fragments and stems of plants and traces of *Glossopteris in situ*. This rests on porphyry, which forms a series of rocky hills two miles further south, extending seven miles south-easterly to the foot of, and underlying, some high table-topped Carboniferous ranges (composed of sandstones, grits, and conglomerates, with silicified wood) in that direction. The Carboniferous range is about five hundred feet above the river."\*

I have always found it very difficult to reconcile Mr. Taylor's observations with my own ideas on the subject of the age of these sandstones. That the "high table-topped ranges" are denuded fragments of the Desert Sandstone I have no doubt whatever. Mr. Taylor naturally, while it was the almost universal belief that the presence of *Glossopteris* proved the formation in which it occurred to be Palæozoic, mapped the tableland as "Carboniferous," and the "Carboniferous Range" still figures on the Map of the Colony. Since, however, Mr. Rands has detected *Glossopteris* in beds belonging to the Desert Sandstone, and resting unconformably on the Lower Cretaceous strata of the Rolling Downs, there need no longer be any difficulty in admitting the Desert Sandstone age of Mr. Taylor's tableland.

Mr. A. Gibb Maitland describes† the Carborough Range at the heads of the Isaacs, as "composed of a series of conglomerates, grits, and sandstones, about five hundred feet in thickness, which are arranged in a series of synclinal troughs, whose longer axes run generally north-west to south-east. The base consists of a coarse, somewhat felspathic grit, dipping at angles from 7° to 9° to S.W.W., the upper portion being much finer in grain, and made up of a fairly fine-grained ferruginous sandstone. Beneath these beds the upper or freshwater series of the Bowen River Beds is observable." The summit of the range is 1,750 feet above the level of the sea, and about seven hundred feet above that of the surrounding country.

The Redcliff Range and its outlying fragment to the north, between the heads of the Bowen River and Cerito Creek, consist of over eight hundred feet of rigidly horizontal beds, mainly of a coarse grit of well-rounded grains of silica with a few quartz and felstone pebbles. Some beds are more felspathic. The grit is white or yellow, but often weathers with a reddish tinge. These tablelands rest unconformably on the Upper or Freshwater Series of the Bowen River Coal Field.‡ When I first saw the Mount Leslie Sandstones in 1878 I doubted their identity with the Desert Sandstone, but a much more extensive acquaintance with that formation has long since removed the difficulties which I then saw.

Mr. Maitland,§ writing in 1889, observes that Mount Leslie is "made up of sandstones, grits, and conglomerates similar to those forming the Carborough Range, of which, physically, it is a continuation."

Between the Sellheim Silver Mines and Mount Conway Station, the granite on the divide between the Two-Mile and Percy Douglas Creeks is covered in places by isolated table mountains, fragments of a once widespread tableland of horizontally

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\* Mr. Taylor's MS. notes, *penes me*.

† Report on Geological Observations at the heads of the Isaacs, the Suttor, and the Bowen Rivers, p. 4. Brisbane: by Authority: 1889.

‡ Report on the Bowen River Coal Field. By R. L. Jack. Brisbane: by Authority: 1879.

§ *Op. cit.*, p. 5.

bedded Desert Sandstone. One of these, which I visited, showed, in the escarpment by which it was bounded, fifty feet of yellow siliceous sandstone, somewhat ferruginous, on fifty feet of white aluminous grit with quartz grains. Again, on the divide between the Sellheim and Rosetta Creek, fragments of the Desert Sandstone tableland are seen on either side of the road from the Silver Mines to Mount Conway, resting on syenite.\*

"On the divide between St. Paul's Creek and Cattle Creek, the granite is capped with beds of Desert Sandstone, which is made up of beds of white sandstone with layers of quartz pebbles, and beds of conglomerate made up chiefly of pebbles of quartz. The Desert Sandstone forms bold cliffs which face the north, and it has gradually thinned away by denudation towards the south. It extends about three miles across in a north and south direction. Beyond this, granite shows again in the creeks and gullies. The Desert Sandstone beds are nearly horizontal."†

In the neighbourhood of Cooktown the Desert Sandstone is seen under some of its most interesting aspects, inasmuch as it contains coal-seams, and is associated with immense outbursts of volcanic activity.

On the north shore of the estuary of the Endeavour River, I saw, in 1879, the lowest beds of the formation resting horizontally on five hundred feet or more of vertical slates. A thick bed of conglomerate at the base was succeeded by about four feet of grey shales, the uppermost eight inches of which were mixed with thin layers of coal.‡

At the heads of Oakey Creek, the Desert Sandstone is seen resting horizontally on the upturned edges of the Bowen River (Permo-Carboniferous) Coal Measures, which in turn lie unconformably on older slates and quartzites.

In 1879 I wrote as follows §:—

"From the starting-point at Cooktown an extensive view is obtained to the north and west, the valleys of the Endeavour and its tributaries forming a depressed foreground, which has the effect of throwing into strong relief the contour of the mountains beyond. No one can fail to be struck by the immense masses of horizontal sandstone which cap the mountains in continuous tablelands at the heads of the Endeavour and Oakey, and in isolated fragments at Cunningham's Range, Connor's Knob, and Cape Bedford. It must be obvious to the most superficial observer that the horizontal deposit must have been continuous at no very distant date, even over the area where it is now only represented by fragments standing alone on pinnacles of slate or granite, and that the southern shores of the waters in which it was deposited were formed by the lofty ranges from which the Annan, Normanby, and Laura Rivers take their rise. North of this limit, or ancient shore, all the mountains which rise to the height of about eight hundred feet above the level of the sea 'catch' (to use a graphic mining term) the even || bottom of the sandstone, while from those which do not attain this altitude, as well as from the valleys, the deposit has been entirely removed by denudation.

"With one notable exception, the sandstone, from the Byerstown Road northward to the Morgan, rests upon a formation of nearly vertical strata of alternating slate, quartzite, and greywacke. The edges of the slates and other upturned strata bear for the most part north and south. The exception referred to occurs in the valley of Oakey

\* Report by R. L. Jack on the Sellheim Silver Mines and Surrounding District. Brisbane: by Authority: 1889.

† Report on the Cape River Gold Field, by William H. Rands, p. 16. Brisbane: by Authority: 1891.

‡ Second Report by R. L. Jack on the Progress of the Search for Coal in the Cook District. Brisbane: by Authority: 1879.

§ Report on Explorations in Cape York Peninsula, 1879-80. By R. L. Jack. Brisbane: by Authority: 1881.

|| Very uneven I have since found it.

Creek, between the Palmerville and Byerstown Roads. There the sandstone overlies, not the slates, quartzites, &c., but a great thickness of strata containing *Glossopteris* [Permo-Carboniferous or Bowen River Beds]. The beds of this formation dip at high angles to the north-west *under* the horizontal sandstone [Desert Sandstone] of the 'Brothers,' which is therefore separated from them by a violent unconformability. As a great thickness of the coal-bearing strata dips under the sandstone of the 'Brothers' on the east side of that range, and *does not* reappear on the west side (where the sandstone rests immediately on slates), the coal-bearing strata must be bounded on the west by a fault which passes beneath, and does not disturb the horizontal sandstones.

"The horizontal sandstone varies in texture from a coarse grit to a fine, hard, compact rock. The materials are for the most part siliceous, but occasionally felspathic. Generally white or yellow, they sometimes have a faint red tinge from the presence of peroxide of iron. Where much iron is present, nodules of fine hæmatite are frequently met with. Pebbles of quartz, quartzite, slate, lydian stone, greywacke, and granite occur near the base of the formation, forming a few beds of conglomerate. In the far north of the Cape York Peninsula, as will be hereafter seen, the upper beds of the formation assume an entirely different aspect. There are very few shaley beds among the sandstones. On the north side of the estuary of the Endeavour, however, some shales are seen crowded with plant-*débris*. Indistinct plant-remains have also been met with on Jane's Tableland. Thin (quarter-inch) coal-seams occur on the north shore near Cooktown, and in Temple Bay."

The Morgan Tableland is a fragment of the Desert Sandstone, about four miles across, and resting on upturned slates.

West of the Morgan Tableland is another large tableland of Desert Sandstone, resting at an estimated elevation of four hundred feet above the sea-level, sometimes on slates and greywackes, and occasionally on granite or porphyry. Its northern edge trends west-north-west, and is drained by the Starcke and Jeannie Rivers. A tributary of the left bank of the Jeannie divides this tableland from another, though less extensive, fragment extending towards Cape Melville. Cape Melville itself, as seen from the sea, consists of apparently a thickness of three or four hundred feet of Desert Sandstone, coming down to the sea-level and slightly undulating. Cape Bowen, to the south, shows also a great thickness of Desert Sandstone, apparently quite horizontal, and resting on slates (?) perhaps one hundred feet above sea-level. At Cape Flattery a great thickness of gently undulating Desert Sandstone beds comes down to the sea in places, and in others highly inclined schists are seen underlying the sandstone in the sea-cliffs. Here the lower third or so of the formation is of brown sandstones and shales, and the upper two-thirds of white sandstone.

At Cape Bedford, as seen from the sea, the Desert Sandstone forms a small isolated tableland perched on slaty rocks, at apparently about four hundred feet above the sea-level.

The tableland, whose eastern extremity at the heads of the Endeavour has already been referred to, is reached by the Cooktown and Palmerville Road, a few miles east of the Normanby River. At its edge it is seen resting on nearly vertical slates and greywackes. After making a "jump-up" of two or three hundred feet, the road passes over horizontal beds of white sandstone, for many miles, but on the left bank of the Normanby a mountain-mass of grey granite is seen, possibly of later date than the Desert Sandstone, at least the absence of granite pebbles at the base of the latter appears to favour that view. After passing the Normanby the road, as far as Battle Camp, passes over, or rather ploughs through, heavy, sandy, level country, the soil being probably all derived from the waste of an underlying horizontal bed. At Battle Camp the road clears the

northern extremity of a "range" of hills (where the blacks made a determined stand against the intrusion of white men on the first rush to the Palmer), and makes more directly for the Palmer. The Battle Camp Range rises to about two hundred feet above the general level of the tableland, and is composed of greenish-grey and sometimes reddish sandstones. Mr. Norman Taylor, of the Geological Survey of Victoria, who accompanied Hann's Exploring Expedition in 1872, found in the Battle Camp Range some fossils, which Mr. Robert Etheridge, F.R.S., described as "a *Hinnites* like *H. lavetrix*, and an *Ostrea* like *O. Sowerbyi*, Eth." The discovery of two fossils not specifically determinable, and of genera which have a wide range in time, does not count for much, but the undoubtedly marine character of the fossils proves at least that this portion of the Desert Sandstone was not of lacustrine, fluvial, or aerial origin. Mr. Taylor's description of the locality is given (from his manuscript notes), as it may aid in the re-discovery of the fossiliferous bed, which Mr. A. C. Macmillan has seen, but which I have searched for in vain on four different occasions:—

"At a point on the north-east side of an isolated table range (since named I believe 'Battle Camp') about four miles west of Camp 42, and close by a blacks' corroboree ground, I discovered, at the foot of the escarpment of horizontal sandstones, a very hard siliceous greenish conglomerate, full of lydite and quartz, and, at its junction with the overlying sandstones, numerous bivalves (*Hinnites* and *Ostrea*). Above is a thick series of greenish and reddish-brown, and also white fine grits and sandstones, with concretionary ironstone bands. The sandstones contain a large quantity of silicified wood, which, with the concretionary ironstone, lies scattered at the foot of the escarpment."

At the "Kennedy Bend" (in "Osmer No. 3" Block),\* the river cuts through a conglomerate (below the level of the base of the Battle Camp Range), containing pebbles of conglomerate, quartzite, quartz, greywacke, slate, and a few of granite. Higher beds of the series rise north of the Bend, to about three hundred feet above the Kennedy. These are horizontal gritty sandstones, white and yellow in colour, with much peroxide of iron, often segregating into concretionary masses. It may be mentioned that these beds are seen to be penetrated by an intrusive mass of pink felsite.

In 1879 I made two traverses across the western portion of the Desert Sandstone Tableland, the first in a south-east direction to the Kennedy Bend, when returning from the Coen Gold Field, and the second from the Bend, and keeping a few miles further to the west, when starting out for Somerset with a Prospecting Party.

On the first course, a distance of thirty-five miles was travelled without seeing anything but red sandy soil, with the exception of a slight ridge of ferruginous conglomerate, another of ferruginous sandstone, and some horizontal beds of white and yellow gritty sandstone in a creek, while to the north-east the continuation of the low range of higher beds seen at the Bend was visible in the distance. It ended in a bluff of one hundred feet of sandstone resting on granite. Our party had to beat about the bluff for five miles before a place was found where the horses could get up. The sandstone of the bluff was a very hard, coarse, ferruginous grit, with ironstone nodules and indistinct plant-remains.

On the second course, we met with very much similar country, but the edge of the tableland was found to present a thickness of at least five hundred feet of sandstone, which we found difficult to descend from on to the underlying granite.† It may

\* See Two-mile Map Kennedy District, Sheet 12, 1889.

† Report on Explorations in Cape York Peninsula, 1879-80. By R. L. Jack. Brisbane: by Authority: 1881.

be mentioned that this part of the tableland is fair pastoral country, to which the term of "Desert" by no means applies.

The base of the tableland is here considerably higher than the watershed of the Cape York Peninsula crossed by us to the north-west.

The Railway from Cooktown to the Palmer (now open as far as the Laura) passes to the south of the Battle Camp Range. After passing the Palmer Road Station (thirty-one miles), and traversing granite country for a few miles (intrusive through the Desert Sandstone, or forming a *very* uneven bottom, over which it was laid down), for six miles, gritty, white, and brownish sandstones, with grey and dark shales, are seen in the railway cutting, dipping at about 15° to the west. Similar strata continue to be seen in the railway cuttings at least as far as forty-one miles and three-quarters, dipping on the whole to the west. At forty-one miles sixty-two chains, I was informed by Mr. Webb, that a two-inch coal seam was exposed by a man engaged in quarrying railway ballast, but the water was so high that I was unable to see it.

A mile south-west of the thirty-nine miles sixty chains peg a branch of Welcome Creek exposes some black shales with coaly streaks. Two miles south-east of this place a shaft has been sunk in the bed of a gully below a waterfall, and on the banks and in the bed of the gully were seen ten feet of grey gritty sandstone, with dark seams and coaly streaks, overlying eight inches of black gritty sandstone, with coaly streaks. The shaft was said to have been sunk eight feet on coal, but when I visited the place (in February, 1887) the creek was, unfortunately, in flood, and I could only grapple for a few samples. The coal had a specific gravity of 1·83, and on analysis gave the following results:—

	Per cent.
Moisture ... ..	8·25
Volatile hydrocarbons ... ..	30·42
Fixed carbon ... ..	42·81
Ash ... ..	19·02

Puckley's Creek (which crosses the Railway near the thirty-seven mile peg), about two miles south of the railway, falls about fifty feet over a wall of granite, which is capped by horizontal gritty sandstone. A mile above the fall, I saw grey sandstone with bands of dark argillaceous sandstone containing imperfectly preserved plant-remains, and little kernels of very good coal dipping down the creek (north) at about 7°. A mile further up, Mr. Webb pointed out a place where he informed me that there was a seam of coal eight inches thick, then under water. About a mile further up the stream the following section was seen dipping slightly down stream (north):—

	Ft. in.
Gritty sandstone ... ..	0 0
Coal ... ..	0 1
Black sandstone ... ..	0 10
Coal, said to be ... ..	1 6

Into the last-mentioned coal-seam I could only grapple for samples, owing to the high level of the water in the creek. The coal had a specific gravity of 1·55, and gave the following results on analysis:—

	Per cent.
Moisture ... ..	7·16
Volatile hydrocarbons ... ..	20·96
Fixed carbon ... ..	35·35
Ash ... ..	36·53

It will be observed from the two analyses that the proportion of ash is very high, but it is quite possible that owing to the floods I may not have succeeded in procuring good, or even fair samples. The samples, however, resemble closely enough some which



I saw in Mr. Webb's possession, and at Cooktown, and which may be presumed to have been collected under more favourable conditions than those obtained by me. Supposing the mechanical impurities represented by the ash, and consisting, in the case of the Welcome Seam, mainly of siliceous, and, in the case of Puckley's Seam, mainly of felspathic materials, to be lessened by about two-thirds, the coal would be valuable for steaming purposes. As it is, the coals burn well enough, but their high percentage of ash would interfere with their usefulness as fuel.

It is reported that in a well at Brown's Station, about a mile north of the northern escarpment of the Battle Camp Range, or Tableland, grey shales were met with, which were supposed to belong to the coal-bearing series of Welcome and Puckley's Creeks.

On the left bank of the Little Laura, opposite Cobb's Coach-stage, while halting there on the journey from the Palmer, I saw an outcrop of horizontal grey clay-shales, which I believed to be part of the Welcome Coal-bearing Series.

Regarding the age of these coal-bearing strata I could ascertain little or nothing, having searched in vain for any recognisable fossils, and found only plentiful carbonaceous streaks representing decayed plant-remains. Mr. George Sweet, of Brunswick, Melbourne, went to the Welcome Valley in June, 1889, expressly to make a similar search, but was hardly more successful, although his collection included what could be recognised as a fern and some reed-like plant-impressions. The strata are characterised by a great paucity of fossils, which is itself a circumstance presenting a marked contrast to the Permo-Carboniferous strata at Deep Creek, Oakley Creek, and the Little River. I suspected from the first that the coal-bearing rocks of the Welcome Valley were part and parcel of the Desert Sandstone, representing, like the coal-bearing rocks on the north shore of the estuary of the Endeavour, a terrestrial or fresh-water phase of the formation,\* and this view has been abundantly confirmed by Mr. Maitland's recent investigations.

Mr. Maitland examined the coal-bearing deposits in the neighbourhood of Cooktown in the end of 1890. His observations, which definitely settle the question of the age of the deposits, are quoted below:—

"The beds of the Endeavour River, the Normanby River, and the Welcome Valley have been examined and described by Mr. R. L. Jack in the years 1879 and 1887. In the description of the latter, no definite conclusion as to the age of the Welcome Valley Beds was arrived at. Subsequent examination shows them to be of Desert Sandstone age.

"Wherever examined they present very much the same lithological characters. For the most part they consist of coarse sandstones, grits, and conglomerates. Many of the sandstones in the higher portions of the series contain large quantities of hæmatite in the form of irregular nodules. Fine-grained flaggy sandstones (with streaks of coal), shales (some of a buff colour), and thin coals also occur, but they form a relatively small portion of the series. A fine ashy sandstone, similar to the sandstone described as occurring at the base of the Desert Sandstone in the Cape York Peninsula, near the Lukin River, at Pera Head, north of the Archer River and Pisonia Island, one of the Wellesley Group, off Point Parker, is to be seen at one portion of Battle Camp Range, resting upon the sandstones and grits to be described below. Nowhere do these rocks appear to have undergone much disturbance since they were formed.

"At Guppy's Tableland, between Cape Bedford and Indian Head, the base of the Desert Sandstone, which rests, with a violent unconformability, upon the upturned edges

\* Geological Observations in the North of Queensland, 1886-7. By R. L. Jack. Brisbane: by Authority: 1887.

of the quartzites, greywackes, and slates, is, by Aneroid, five hundred and sixty feet above the high-water mark on the beach. The lowest bed consists of a coarse quartzose conglomerate of seventy feet in thickness, succeeded by about fifty feet of fine-grained flaggy sandstones, with shales and thin coals, and in turn overlain by about three hundred feet of coarse massive grits.

"The following is a section in descending order:—

	Ft.	in.
Massive grits with coal streaks ... ..	300	0
Carbonaceous shale with thin sandstone partings ... ..	7	0
Coal (Guppy's seam) ... ..	0	6
Fine-grained sandstone with thin shales ... ..	6	0
Black sandy shale with coal streaks ... ..	3	10
Sandstone ... ..	2	0
Shale... ..	0	6-8
Sandstone ... ..	0	10
Dark shale with coal streaks ... ..	0	6
Fine grained sandstone (with an irregular base) and thin shales ...	6-8	0
Fine grained flaggy sandstone with thin lenticular beds of sandy shale ... ..	10-12	0
Quartzose conglomerate ... ..	70	0

"Guppy's coal-seam has been opened up, but no fresh light is thrown upon the section. There is no underclay or 'seat earth' beneath the coal. A sample of this seam, collected by myself, yielded on analysis:—

Moisture ... ..	2.32
Volatile hydrocarbons ... ..	15.20
Fixed carbon ... ..	72.83
Ash ... ..	9.65

100.00

The specific gravity is 1.66. The ash is of a yellow colour.

"None of the beds in the section at Guppy's Tableland have yielded any fossils with the exception of a few plant-remains, rootlets and fragments of leaves, from some of the carbonaceous shales. Fragments of coal are not uncommon in the upper grit.

"The section exposed at Indian Head is similar to that at Guppy's Tableland, with the exception that the total thickness of strata is not so great, there being only about three hundred feet. The base lies at an altitude of about eight hundred feet above high-water mark. The lower and upper grits are continuous from Guppy's Tableland, but they are separated by a smaller thickness of flaggy sandstones and very sandy shales. A seam of coal is said to occur among these beds, doubtless a continuation of that seen in Guppy's Tableland.

"From this point westwards, the next outlier of sandstone is at Mount Fantastic; this consists of about one hundred feet of sandstone, with neither shales nor coal.

"The tableland between Mount Fantastic and Connor's Knob is of sandstone, as is also Connor's Knob.

"In examining the cliffs to the north of the Endeavour, near its head, I saw nothing of any of the shales, the whole section appearing to be coarse massive sandstones.

"The hills in the neighbourhood of Brannighan's Bluff, in Isabella Creek, are reported to contain a thin seam of coal.

"Crossing the divide into the waters of the Normanby, the Desert Sandstone Beds are found to be represented by sandstones and grits without any of the intervening

shales. The base, near the railway, is at an altitude of four hundred feet above the sea-level. In the distance intervening between Indian Head and the Normanby the coal-bearing shales have disappeared. The shales make their appearance, however, in a small synclinal trough seen in the railway cuttings near the thirty-seven-mile peg, at an altitude of about four hundred and thirty feet above sea-level, or two hundred feet below the horizon of those at Indian Head. At the eastern end of the section, at the thirty-six-mile peg, the Desert Sandstone Beds rest presumably upon granite, which is seen *in situ* two hundred yards distant to the southwards. A ridge of massive quartzite is seen to rise from beneath the sandstones at the thirty-seven-mile peg.

"A cutting to the east of Battle Camp Creek exposes a conglomerate, with pebbles of greywacke and quartzite, resting unconformably upon the massive quartzite mentioned above. The conglomerate is covered with four feet six inches of black shale, and that again by sandstone, the whole series dipping at angles varying from 5 to 7 degrees to the east. Buff-coloured sandstones are seen to lie beneath those at the thirty-seven and a-quarter-mile peg.

"A cutting at the 37 $\frac{1}{4}$ -mile peg shows nothing but very false-bedded sandstones of a reddish-white hue, with a few 'false dykes'—*i.e.*, fissures which have subsequently been filled in with sandy matter. Beneath this false-bedded sandstone lies three feet of shale, which dips at 5 degrees to the west. This rests on a continuation of the sandstone seen at the 37 $\frac{1}{4}$ -mile.

"Dipping at 3 to 5 degrees to the north is a bed of black shale, at the 38-mile. At the 38 $\frac{1}{4}$ -mile this is underlain by greyish sandstone with ironstone nodules. The hills on either side of the line are made up of nearly horizontally bedded rocks.

"Coarse grit, conglomerate, and a thin bed of shale are seen in the cutting at the 38 $\frac{1}{4}$ -mile. Some of the coarser grits and conglomerates contain kernels of shale. On the south side of the line, near the 39-mile peg, granite rises from beneath the grits.

"About a mile and a-half south of the 40-mile peg a bed of carbonaceous shale with coal streaks, crowded with reed-like plants, too fragmentary for determination, is laid bare in one of the branches of Welcome Creek. The shale has a dip of 5 degrees to the west-south-west; it rests upon a bed of fine-grained sandstone of a greenish hue. A shaft has been sunk upon the shales, but apparently abandoned a long time previously.\* A traverse from this point to the foot of the highest point in the district—a conspicuous hill two miles to the south—shows nothing else but well-nigh horizontal sandstones. The sandstone capping the summit of the hill is very fine-grained; its mural face contains many small caves, which have apparently served as hiding-places for the natives. As viewed from the summit, the whole of the Welcome Valley appeared to be made up of similar bedded rocks.

"Fine-grained yellowish sandstone, with a low dip to the west, is laid bare at the 40 $\frac{1}{4}$ -mile peg.

"The Battle Camp Range lies to the north of the line at this point. It is composed of alternations of grits and sandstones, disposed with a gentle dip to the south-east: one bed was found to contain annelid tracks (?). The summit, 870 feet above sea-level, is made up of a fine ashy (?) sandstone, which rests apparently conformably upon the other rocks. This ashy (?) sandstone only attains a thickness of about forty feet, and is not continuous over a larger area. In its lithological characters it agrees with those occurring further north in the Cape York Peninsula. I searched in vain for fossils, annelid tracks (?) being all I could discover. (It was from the northern face of this

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\* See p. 532.

range that Mr. Norman Taylor, the Geologist attached to Hann's Expedition in the year 1872, discovered *Hinnites* and *Ostrea*.) From the summit, as far as the eye could reach, nothing but horizontally bedded rocks could be seen.

"A little distance east of the 41½-mile peg a quarry has been opened for ballast on a horizontal sandstone of the usual type. A similar sandstone is seen in a cutting between the 43½ and the 43¾ mile pegs.

"Another ballast quarry has been opened to the south of the line—the 44½-mile, and distant about one hundred and fifty yards; the sandstone is fine in grain and of a white colour.

"Reddish-yellow, fine-grained sandstone dips to the east at angles varying from 5 to 10 degrees in the vicinity of the 44¾-mile peg.

"A conspicuous escarpment of coarse gritty sandstone trends east and west, distant about two hundred yards to the south of the 47½-mile peg; a similar cliff—probably a continuation—occurs about half-a-mile to the south-east of the 49-mile peg.

"In the vicinity of the 55½-mile, within two hundred yards of the line, on the south, a series of fossils were collected from a bed of fairly coarse grit which occupies the greater portion of the neighbourhood. The fossils, which resemble very closely those occurring in the Desert Sandstone of Croydon, consist of *Maccoyella* (?), internal casts of *Rhynchonella*, and others which I have not yet been able to determine.\*

"From this point to the railway terminus at the Laura River, nothing but sandstones of the usual type occupy the country on both sides of the line.

"Five miles up the Laura from the railway crossing, the following section is seen, in descending order, in a cliff in the river:—

							Ft. in.
Grits with pebbles	...	...	...	...	...	...	8 10
Shale ...	...	...	...	...	...	...	1 0
Coal ...	...	...	...	...	...	...	0 2
Shale ...	...	...	...	...	...	...	0 3
Grey sandstone	...	...	...	...	...	...	0 0
Sandy shale ...	...	...	...	...	...	...	0 10
Fine-grained sandstone	...	...	...	...	...	...	1 8
Bluish sandy shale	...	...	...	...	...	...	1 9
Coal ...	...	...	...	...	...	...	0 5
Sandy shale ...	...	...	...	...	...	...	1 6
Sandstone ...	...	...	...	...	...	...	0 0

"The whole of the beds lie horizontally. In this section there is an absence of underclay or seat-earth beneath the coal.

"An instructive section is to be seen in Puckley or Sandy Creek. The altitude of Mount Ruby Station is, by Aneroid, 420 feet above sea-level. A traverse from this point to the divide between Leichhardt and Puckley Creeks showed coarse grits, lying horizontally upon granite, at 1,000 feet above sea-level. The summit of the divide is 1,250 feet, thus giving a thickness of two hundred and fifty feet of sedimentary rocks at the head of Leichhardt Creek. When, however, the waters of Puckley Creek are followed down, it is found that the thickness of the sedimentary beds has increased to five hundred and twenty feet.

"From the summit to 850 feet the whole of the rocks consist of coarse grits and conglomerates. At 380 feet below the summit, or 870 feet above sea-level, two seams of coal are seen to be interstratified with the grits. A section in the bank of the creek shows the lower seam of coal to be nine inches in thickness, three inches of the base of which is crowded with quartz granules to such an extent as to make it an

\* This locality, by the Railway Survey, is about 468 feet above sea-level.

open question whether the rock should be called coal or merely a carbonaceous grit. Above this nine-inch seam lies a bed of grit two inches thick, and this is covered by another coal seam of four inches. A sample of the coal from the upper portion of the nine-inch seam was taken and submitted to analysis, with the following result:—

Moisture ... ..	0.33
Volatile hydrocarbons ... ..	30.13
Fixed carbon ... ..	39.34
Ash ... ..	30.20
	<hr/>
	100.00

The specific gravity is 1.51. The ash is grey in colour.

"A little distance west-north-west from the outcrop in the creek a shaft had been sunk through sandstone, to a depth unknown to my informant, with the object of meeting the coal. The shaft had been abandoned some time, and I was unable to descend.

"In the section described above there is an absence of underclay or seat-earth. The coal rests directly upon coarse grit. It would appear as though the coal had been formed in such a position as would allow of the access of sandy matter. The high percentage of ash, as well as the gritty character of the base, gives credence to this view.

"Following the windings of the creek for a mile or two down its course, sections show nothing but fine-grained argillaceous and micaceous sandstones, with nodules of ironstone and small pellets of coal. The beds roll about a good deal, but their dip never measured more than from 5-7 degrees northwards. They rest upon a coarse sandstone described \* as occurring at the spot where Puckley Creek falls over a wall of granite 50 feet high. From this point to the railway the country is occupied by granite of the usual type.

"About a mile below the Railway Bridge a bed of coarse sandstone dips at a low angle down the creek; it is seen to rest upon granite.

"It will be seen from the altitudes given that the Welcome Valley beds occupy a position below those at the head of Puckley Creek.

"For the purpose of comparison, the analyses made of the Desert Sandstone coals have been thrown into a tabular form.

"The description of the localities from which the coals analysed by Mr. R. L. Jack were obtained need not be repeated—it will be found by referring to the Report on 'Geological Observations in the North of Queensland' already quoted.

"ANALYSES OF THE CRETACEOUS COALS OF THE COOKTOWN DISTRICT.

—	1	2	3	4
Moisture ... ..	8.25	7.16	0.33	2.32
Volatile hydrocarbons ... ..	30.42	20.96	30.13	15.20
Fixed carbon ... ..	42.31	35.35	39.34	72.83
Ash ... ..	19.02	36.53	30.20	9.65
Specific gravity ... ..	1.83	1.55	1.51	1.66

"1. *Locality*.—About three miles south of the 4-mile peg, Cooktown Railway; analysed by R. L. Jack.

"2. *Locality*.—About four miles up the Valley of Puckley Creek, above the Railway crossing; analysed by R. L. Jack.

"3. *Locality*.—Near the head of Puckley Creek; analysed by A. Gibb Maitland.

"4. *Locality*.—Guppy's Tableland, North Shore; analysed by A. Gibb Maitland.

\* "Geological Observations in the North of Queensland." R. J. Jack. Brisbane: by Authority.

"After entering the valley of Welcome Creek, it will be seen that the thickness of the Desert Sandstone beds increases somewhat rapidly to the westwards. At the 36-mile peg their base is, from the Railway Survey, 348 feet above sea-level. Between this point and the Laura Terminus, which is 269 feet in height, the country is occupied by one continuous series of sedimentary rocks, disposed in a series of scarcely perceptible undulations, but with a gradual dip westwards.

"The total thickness of strata at the head of Puckley Creek is five hundred and twenty feet; between the base of these and the top of the grits seen below the Puckley Creek Bridge, 350 feet above sea-level, there is room for not less than five hundred feet of rock. The sandstones of the Battle Camp Range, which rise to a height of 500 feet above the beds at the 36-mile peg, are probably the representatives of the beds which occupied this gap.

"The Welcome Valley beds—by which term is meant the whole of the series of rocks between the 36-mile and the Laura terminus—thus occupy a position below those described as occurring at the head of Puckley Creek, and also below those of the Battle Camp Range. It would be rash to venture upon an estimate of the thickness of the beds of the Welcome Valley, for there has been no evidence brought forward to throw any light upon this point.

"The minimum thickness of Desert Sandstone lying above the 36-mile peg, where the Welcome Valley beds are first seen, is not less than one thousand feet—more than double that occurring in the Endeavour waters.

"Another point which the examination of this district has brought out is the existence of a ridge running approximately parallel with the Normanby River north and south. To the west of this ridge was a valley or hollow in which the Welcome Valley beds were deposited. Where the western boundary of this hollow existed it would be premature, with the meagre evidence before us, to state. To the southwards, however, near the head of the Laura River in the Palmer River waters, the Railway Survey gives the altitude of the base of the Desert Sandstone as being 1,100 feet above sea-level.

"A circumstance worthy of note is the entire absence of an 'underclay' or 'seat-earth' from any of the Cretaceous coals of this district which have yet been described. The coals either rest directly on grit or very sandy shale, and one of the coals—that from Puckley Creek—has its base crowded with quartz grains. Some of the shales contain very thin laminæ of coal, which are not continuous for any great distance. These peculiarities are due to the conditions under which the coals were formed."

In the Valley of the Little Kennedy, one of the heads of the Kennedy River, highly inclined slates are seen on the left wall of the valley, capped by horizontally bedded conglomerates and coarse gritty sandstones, forming a portion of the tableland which has already been partly described. On the right wall of the valley the slates rise to a much greater elevation than on the left, and must have formed a portion of the shore of the waters in which the Desert Sandstone was deposited. The floor of the valley shows Permo-Carboniferous rocks (including coal-seams) let in by two north and south faults between the two masses of slate. The Permo-Carboniferous rocks, as well as the older slates, must have been covered unconformably by the Desert Sandstone.\*

On the Road from Cooktown to Palmerville, about four miles short of the latter, the base of the Desert Sandstone forming this extensive tableland is again seen resting on vertical slates and a thick limestone bed. The Desert Sandstone here presents

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\* Report by R.L.J. on the Little River Coal Field, near Cooktown. Brisbane: by Authority: 1882.

a precipitous escarpment of about four hundred feet in height, and consists mainly of two beds—the upper of red sandstone, with a white band in the middle; and the lower of a coarse conglomerate containing pebbles of quartz, gneiss, and granite in a matrix of sharp white sand. The same escarpment can be traced eastward to near the head of the Palmer, forming the right wall of the valley. The surface of the tableland on the Road from Cooktown to Maytown (on the top of the cliff overlooking the latter) is given by Mr. Surveyor White as 1,500 feet, while Maytown is 800 feet. Mount Hann and the “High Mountain” between the escarpment and the Palmer River rise respectively to 2,250 and 2,300 feet, and must have stood up as islands in the Desert Sandstone waters.

Mount Daintree, about ten miles west of Palmerville, is an outlier of the Desert Sandstone, resting on gneiss, and forms a tableland of about ten acres in extent, bounded by sheer cliffs, two or three hundred feet in height, which can only be scaled in one place. On this tableland the timber is stunted and the grass (*Triodia*) is totally different from that on the surrounding land. The cliff is composed of thick-bedded red and white siliceous sandstone. One fine-grained white laminated bed is full of plant-remains, which, however, are quite undistinguishable, though somewhat reed-like in general appearance. This bed is probably identical with the “white band” above referred to as occurring in the middle of the upper bed seen on the Palmerville and Cooktown road.

From Mount Daintree I obtained (in 1887) a good view of the surrounding country. Escarpments of Desert Sandstone extended along the north wall of the valley of the Palmer, at distances varying from three to twelve miles, almost without interruption, from a point bearing N.N.W. of the mountain to beyond the Maytown and Cooktown roads. Subtending an angle from N.N.W. to S.W. of Mount Daintree, the whole of the country, as far as the eye could reach, was low and nearly level. (This is the position assigned by Mr. Norman Taylor to a “Carboniferous Range” in the Map attached to the account of Hann’s Northern Expedition.) About ten miles south-south-west of Mount Daintree, high escarpments of horizontal strata were visible, probably further outliers of the Desert Sandstone.\*

In a Map of the Squatting Runs down the Palmer furnished to the Lands Department by Messrs. White and Embly, the words “Desert Sandstone” are written across the back of “Meron Downs” Block on the left bank of the Palmer, and across the centre of “Strathleven No. IV.” Block on the right bank of the same river (opposite its junction with the Mitchell). I have not seen these localities, but as I know Mr. White to be a trustworthy observer, I regard the information as reliable, especially as it agrees with Daintree’s observations on the Lower Gilbert.

Mr. James V. Mulligan, after leaving Palmerville on a prospecting trip, keeping round the south-western end of the Main Desert Sandstone tableland, had to cross another small table-land between the Palmer and Fahey Creek.†

Much of the alluvial gold of the Palmer Gold Field has been derived from the immediate neighbourhood of the “Conglomerate” or Desert Sandstone tableland, and in positions where it is impossible to ascribe its presence to the degradation of local reefs. As there is no evidence of any submergence of this district beneath the sea between Permo-Carboniferous and Cretaceous times, it is probable that the area covered by the Desert Sandstone was a land surface for an immensely greater period prior to the deposition than it has been since the elevation of the Desert Sandstone, and the uneven

\* Report of the Government Geologist, in Annual Report of the Department of Mines for 1887.

† Report on Expedition in Search of Gold, &c., in the Palmer District by Mulligan and Party. Brisbane : by Authority : 1876.

bottom on which the Desert Sandstone has been deposited corroborates this view. Now, if we admit that what was a land surface from Permian to Cretaceous times still lies beneath the Desert Sandstone, we may confidently expect to find beneath it numerous ancient watercourses, in which the *débris* from a very much larger area of auriferous rocks than has been exposed since the denudation of the Sandstone must have been "sluiced" again and again, so that the gold may be in "leads" in a highly concentrated form. I began to insist upon this view in 1886, and it is satisfactory to note that since then payable gold has been obtained in consolidated drifts or "cements" between the base of the Desert Sandstone and the surface of the slates to the north of the Palmer.

Mr. Daintree, in 1872, expressed the opinion\* that "the very nature of its [the Desert Sandstone's] deposition seems to preclude the idea that gold will be found in paying quantities, except where direct local abrasion of a rich auriferous veinstone has furnished the supply. It is, indeed, doubtful if any *marine* or *extensive lacustrine* beds, except on their shingle margins, have produced, or are ever likely to produce, remunerative workings of *free* gold, for the simple reason that the majority of the sediments of which they are composed are derived from formations the greater part of which were non-auriferous." My own conviction is that in the Palmer district deep leads, containing an amount of gold which will dwarf into insignificance the four or five million pounds worth already obtained from the field, will yet be found *beneath*, if not in, the Desert Sandstone. Where an old land surface composed of auriferous rocks is covered over by a newer deposit, it is likely that the deep leads thus preserved from denudation will prove rich in gold. It matters nothing whether the covering be of basalt or sandstone.

The same remarks as to the presence of alluvial gold beneath the Desert Sandstone apply to many other fields in the Colony. At the Upper Gilbert, at Croydon, at the Cape, at the Hodgkinson, at the Starcke, and at Cania, the bulk of the alluvial gold has been obtained from localities from which the Desert Sandstone has been recently denuded. In fact, when one thinks of it, the places where alluvial gold has been found in conspicuously large quantities are just the places where these conditions prevail, and not the places where the local reefs are richest. I have seen some suggestive instances on the Palmer where rich gold has been obtained from gullies within the whole drainage area of which there was no reef whatever. This may seem a bold assertion, but the country was dry, the grass had been recently burnt, and every bed of shale and sandstone in the drainage area was laid bare. Again, north of Tambo, alluvial gold (I believe in small quantities) has been found in Windeyer Creek and gullies which rise in the Desert Sandstone and flow over the underlying Rolling Downs rocks. As the latter certainly contain no auriferous reefs, the probability is that the gold was derived from "leads" beneath the Desert Sandstone.

On our northward course to Cape York in 1879-80, we first struck the Desert Sandstone between the Lukin and Kendall rivers, in about Long. 143° E. The sandstone at its eastern escarpment had a thickness of about fifty feet, and was about 200 feet above the level of the plain. It was ferruginous and very hard, and appeared to be partly composed of fine volcanic dust. It contained little pebbles of quartz and larger pebbles of slate and quartzite. A granite mountain attaining a higher elevation than the sandstone lay between it and the Lukin River. It is very probable that the base of the Desert Sandstone rises gradually from near the sea-level on the Lower Norman and Gilbert (where Daintree observed it) to the higher level near the junction of the Palmer and Mitchell, where it is marked on the Plan of "Strathleven No. IV." Squatting Block, where palæozoic rocks rise from beneath it. It would thus have

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\* Q.J.G.S., xxviii., p. 278.



a gentle dip to the coast of the Gulf of Carpentaria. Its eastern escarpment, in all probability, from "Strathleven No. IV." Block, keeps nearly the meridian of  $143^{\circ}$  E. as far north as the divide between the Lukin and the Kendall.

Between the South Coen and the Peach River, our course took us over a considerable area of the Desert Sandstone, presenting a steep escarpment to the east, which I named the Geikie Range. The sandstone lies on granite. The Geikie Range is cut through by the Peach. Our course, however, lay among the mountains (at a much higher elevation) to the east, so that we only saw this portion of the Geikie Range or tableland. I may say, in passing, that on this portion of our journey we had a good deal of skirmishing with the natives, who managed to kill the horse I was riding by a spear-thrust just behind the saddle, and to wound the horse which carried another member of the party, so that the acquisition of geological information was not altogether unattended with difficulty.

Between Canoe Creek and the Pascoe, outliers of the Desert Sandstone rest on the tops of granite hills, while on the western or left bank of the Pascoe the escarpment which prolongs the Geikie Range to the north continues in an unbroken line. Granite mountains (the Janet Range) rise to the east of Canoe Creek to a height of 1,245 feet. Far to the west (the eastern escarpment of the tableland forming the watershed between the Batavia—Gulf waters—and the Pacific waters at the heads of the Pascoe), a second escarpment marks the eastern limit of a higher bed of the Desert Sandstone. This, which I named the Wilkinson Range, is now included in "Merkunga" and "Merkunga South" Squatting Blocks. The greater part of the Desert Sandstone country between Latitudes  $12^{\circ}$  and  $16^{\circ}$  S. is now taken up on pastoral leases (except within the nominally "settled district" extending thirty miles from the coast on both sides of the peninsula, and in which the terms are less easy), so that the term "Desert" cannot apply to it.

Near the mouth of Canoe Creek we found the Desert Sandstone occupying both sides of the creek. Where this creek joins the Pascoe we built a canoe, or dug-out, by which we crossed the flooded river. This must be about fifteen miles above the spot where in 1848 the gentle and unfortunate Explorer Kennedy left the remainder of his party when he set out on foot, accompanied only by his blackboy "Jacky-Jacky," to meet his fate at the "Escape Inlet," within sight of the ship which was to bring him relief. The hills at Fair Cape were doubtless the last objects that met the eyes of his companions as one by one they sickened and died, while waiting for the relief which was to come too late for all but two of the number.\*

North of the Pascoe we ascended to the top of a high escarpment of Desert Sandstone (to which I gave the name of the Sir William Thompson Range). This tableland extends from the valley of the Pascoe in Long.  $143^{\circ} 3'$  E., and Lat.  $12^{\circ} 40'$  S., north-north-eastward to the 12th parallel, and presents a steep escarpment to the Pacific, and a long gradual slope towards the Gulf. The bed of sandstone of which the tableland is composed is about five hundred feet in thickness, and is reddish and cemented with iron oxide. A lower shelf which crops out from beneath it is of yellow and white sandstone, occasionally containing a few pebbles. The tableland and the lower shelf decompose into soils which have a world-wide difference, the former being clotted with good grass, and well timbered with stringy-bark, bloodwood, *Pandanus*, and *Xanthorrhœa*, while the latter was mainly covered with thickets of heath, and, as far as grass was concerned, was a veritable desert. The lower beds of the shelf abut to the east against serrated mountains rising to 2,342 feet, which I named the Carron Range, in commemoration of the tragic circumstances connected with Dr. Carron's stay when Kennedy left him

\* Narrative of the Voyage of H.M.S. "Rattlesnake." By John McGillivray, F.R.G.S. Vol. ii. London, 1852.

to set out on his last forlorn expedition. About Lat.  $12^{\circ} 30' S.$  we saw the base beds of the Desert Sandstone resting on granite. At the south-west corner of Temple Bay we descended for about two hundred feet over the edges of the lower shelf of Desert Sandstone to the porphyry on which it rests. The Desert Sandstone comes down to the sea-level at Temple Bay. At Bolt Head, in Temple Bay, thirty feet of horizontal reddish sandstone lay unconformably on a blue limestone, at least a hundred feet in thickness, and dipping at  $45^{\circ}$  to the east.

Further north the "Remarkable Red Cliff" of the Admiralty Charts showed two coal-seams, each a quarter of an inch in thickness, in the midst of red sandstone.

As far north as Camisade Creek the thick upper bed of sandstone forming the Sir William Thompson Range and the lower shelf continued to present the same features, the top of the eastern scarp of the former, although only a few miles from the Pacific, being the watershed of the Peninsula. Camisade Creek and Bay, it may be mentioned, were so named from the circumstance that here we had further trouble with blacks, who this time, in the middle of the night, threw, among others, a spear which went clean through the deltoid muscle on the right side of my neck.

An uncharted island, close to the coast, at a point bearing  $S. 26^{\circ} W.$  from the south-east end of Fern Island, is of horizontal Desert Sandstone. At this point and at the mouth of Henderson Creek the red sandstone is highly ferruginous and has a pisolitic structure. There is evidently a very gentle dip in the sandstones northward from the Carron Range, so that although the dip is almost imperceptible we gradually pass over higher beds.

Among the intricacies of the swamps between the Escape Inlets and the Jardine River we found the sandstone to be brown and ferruginous, with a pisolitic structure.

Both sides of the Albany Pass are composed of nearly horizontal beds of sandstone. Similar beds of sandstone are seen in Mount Adolphus Island to the north. Towards Cape York slates rise from beneath the sandstone. At Thursday and adjacent islands slaty rocks rise to a considerable altitude, but the Desert Sandstone is seen in numerous headlands at the level of the sea.

About a mile west of Mount Morgan, near Rockhampton, is a mass—apparently about a hundred and fifty feet in thickness—of horizontally bedded Desert Sandstone. It rests, at this point, apparently on a mass of diabasic dolerite,\* but in other places it may be seen lying on the upturned edges of quartzite and greywacke strata of Permo-Carboniferous age (like the Gympie beds) similar in character to those of the "country" round Mount Morgan. The base of the Desert Sandstone is a mass of fine volcanic dust, while the upper beds are coarsely gritty, and for the most part siliceous, varying from white to brown and red. I should judge the base of the formation to be about one hundred feet lower than the summit of Mount Morgan, or one thousand one hundred and twenty-five feet above the sea. The grit and conglomerate beds at the base of the Desert Sandstone in this district contain, as in the Palmer District, gold, apparently in payable quantities. (Mount Victoria.)

Standing on the sandstone cliffs, so as to look eastward past the south side of Mount Morgan, the observer can descry, across the valley of the Dee, the familiar contour of horizontally bedded sandstone cliffs stretching from north to south over the divide between the waters of the Dee and Gavial Creek. As nearly as can be judged by the eye they are on the same level as the cliffs on the opposite side of the valley, and

\* See Notes on a Collection of Rocks and Minerals from Mount Morgan. By C. S. Wilkinson, T. W. Edgeworth David, and William Anderson. Records of the Geological Survey of N.S.W. Vol. ii, Part 3, 1891.

there can be no doubt that the valley has been carved out of a once continuous cake of sandstone. In this valley the hot spring which gave rise to the auriferous deposit of Mount Morgan subsequently broke out, as will be seen in a succeeding chapter.

In describing the Cania Gold Field \* Mr. Rands writes :—

“A very conspicuous feature of the neighbourhood is the two long and lofty lines of sandstone cliffs, which at the Cania Diggings are some six or more miles apart ; but further down the creek, six or seven miles towards Cania Station, they approach one another, forming high precipices on either side of the creek, and leaving only a narrow gorge through which the road to the station passes.

“The cliff on the left-hand side, going down the creek, is perpendicular and almost continuous for over twelve miles, and is never much more than a mile distant from the Three Moon Creek. About two miles from the Township, where it must be at least three hundred and fifty feet high, it has the appearance of the walls and battlements of an old castle, giving to the hill the name of the “Castle Mountain.” The cliff on the opposite or right-hand side of the creek is only perpendicular for short distances here and there, and generally presents more of a sloping face.

“These cliffs consist of a white gritty sandstone, in parts stained red or brown with oxide of iron. Every few feet, or even oftener, there are layers of a coarse grit, or bands of rounded pebbles of white quartz, varying in size from one-quarter to three inches in diameter. These bands serve to show the original stratification of the mass, which is overlying the older rocks unconformably, dipping 5 degrees to S., 15 degrees E. False-bedding in this sandstone is very frequent. The sandstone is very cavernous ; the face of the cliff has weathered, and where there has been least cohesion between the particles of sand large caverns have been formed.

“These cliffs, standing perpendicularly, as they do, two or three hundred feet high, and opposite to one another, bear witness to the great amount of denudation which has taken place, for the whole country round about must have been formerly overlaid by this formation ; its horizontality points to the fact that there has been but little disturbance since its deposition.”

Mr. Rands estimates the altitude of the base of the Desert Sandstone in this locality roughly at 1,400 or 1,500 feet.

In Mr. Rands' Report on the Albert and Logan District,† he writes of the Desert Sandstone as follows :—

“This formation, which at one time covered the greater part of Queensland, is met with towards the heads of Nerang Creek, near Mr. Nixon's selections. It forms the summit of the ranges between Mudgeeraba and Nerang Creek, and between Nixon's Creek and Back Creek.

“The thickness of this deposit is about one hundred and fifty feet, some distance down the ranges ; and increases to three or four hundred feet towards the heads of the creeks. It stands out in bold perpendicular cliffs, full of small hollows or caves. At its base the deposit is a conglomerate, composed of rounded pebbles and boulders of basalt, similar to that met with in the neighbourhood. Some of these boulders are over 15 inches in diameter. Higher up, the rock consists of granular siliceous sandstone, with thin layers of coarse quartz pebbles.

“The formation here certainly appears to be an ordinary sedimentary deposit, and not of volcanic origin, as suggested by the Rev. J. E. Tenison Woods in a paper read lately before the Royal Society of New South Wales.”

\* Report on the Goldfields of Raglan, Calliope, Milton (Norton), and Cania, &c. By William H. Rands. Brisbane : by Authority : 1885.

† Brisbane : by Authority : 1889.

The sandstone overlies part of the mass of basalt "which is found capping nearly all the higher ground of the district right away from the plains of the Darling Downs, near Laidley, Grandchester, Ipswich, Waterford, Mount Tambourine, on the dividing ranges between the Logan, Albert, and Coomera Rivers, and Nerang, Mudgeeraba, Talleebudgera, and Curambin Creeks.\* It is also met with at Burleigh Heads, Corumbin Heads, Point Danger, and on the Macpherson Range." Mr. Rands informs me that the base of the Desert Sandstone in this locality must be at least one hundred and fifty feet above the sea.

In the Gympie District Mr. Rands describes the Desert Sandstone as follows:—

"This is a coarse-grained silicious sandstone, or freestone, which overlies the Gympie Beds [Permo-Carboniferous] in various places. The rock is made up of coarse granules of quartz. It lies horizontally, but nearly everywhere exhibits 'false-bedding'; the true bedding of the rock can be detected by thin layers of coarse pebbles of quartz. A large outlier of this sandstone can be traced from Eel Creek, crossing the Mary near the Fisherman's Bend, where it forms high banks to the river. It has been quarried as a building stone near Eel Creek, on Mr. Dan. Henry's Selection, No. 882, and it has been used in several of the principal buildings in the town. Outliers of this stone also occur a few miles north of Gympie, near the Maryborough and Gympie Railway Line." † Mr. Rands believes the base of the Desert Sandstone to be here one hundred and fifty feet above the sea-level.

Mr. Daintree, in 1872,‡ referred to certain beds which "crop out at the township of Maryborough, and have been used by the Corporation as quarries for road-metal," and gave a list of fossils therefrom, as determined by Mr. Robert Etheridge, F.R.S. These beds Mr. Daintree regarded as the upper portion of the Burrum Coal Measures, and occupying "a position between the Gordon Downs and Flinders River series." More recent and extensive collections of fossils do not at all bear out this view, the fossils on the contrary bearing a very close correspondence with those of the Desert Sandstone at Croydon. Probably Mr. Daintree made only a hasty collection of fossils, as he does not even give a description of the strata.

Mr. Rands has within the last few years carefully mapped out the beds and shown their relation to the underlying Burrum Coal Measures. In his "Report on the Burrum Coal Field,"§ he says, "The Maryborough Beds have been quarried about one mile west-north-west of the Railway Station by the Corporation for road-metal, and by the Government two miles further out in the same direction for railway ballast. The rock quarried is a fine-grained, light brown or grey sandstone. These beds contain numerous shells.

"At the Corporation quarry the strata consist of light-coloured, fine-grained sandstones, dipping 12° to N. 35° E.

"About a mile and a-half further along the Gayndah Road, and close to the Mary River, about half a mile from what is known as the Copenhagen Bend of the river, is the first of the Government Quarries. The dip is about 7° E. The rocks showing are:—

	Pt.	in.
Broken sandstone ... ..	8	0
Grey, fine-grained sandstone (fossiliferous) ... ..	2	0
Band of laminated sandstone ... ..	0	6

\* I, for one, rejoice that the sentimental feeling which leads to the retention of unpronounceable native names, for the most part conveying no meaning, and which, I believe, in some cases, will not bear translation, is not universal. R.L.J.

† Report on Gympie Gold Field. By William H. Rands. Brisbane: by Authority: 1889.

‡ Q.J.G.S., vol. xxviii., p. 283.

§ Brisbane: by Authority: 1886.

								Ft.	in.
Grey sandstone (fossiliferous)	...	...	...	...	...	...	...	2	0
Band of laminated sandstone	...	...	...	...	...	...	...	0	8
Brown sandstone	...	...	...	...	...	...	...	6	0
Brown shaley sandstone	...	...	...	...	...	...	...	0	4
Greyish-brown sandstone (fossiliferous)	...	...	...	...	...	...	...	7	6
Fine laminated grey shale	...	...	...	...	...	...	...	0	5
Grey sandstone (fossiliferous)	...	...	...	...	...	...	...	2	3
Shaley band	...	...	...	...	...	...	...	0	4
Grey sandstone (fossiliferous)	...	...	...	...	...	...	...	4	0
Black shale	...	...	...	...	...	...	...	0	10
Hard dark-grey laminated sandstone (fossiliferous)	...	...	...	...	...	...	...	2	4
Shale	...	...	...	...	...	...	...	0	2
Grey sandstone (fossiliferous)	...	...	...	...	...	...	...	1	9
Laminated argillaceous sandstone	...	...	...	...	...	...	...	0	8
Dark-grey sandstone	...	...	...	...	...	...	...	2	0
								41	9

are:— “A quarter of a mile further up, exposed in another quarry, dip 7-8° N. 35° E.,

								t.	in.
Brown sandstone with band of carbonaceous shale	...	...	...	...	...	...	...	6	6
Black carbonaceous arenaceous shales (fossiliferous)	...	...	...	...	...	...	...	2	7
Soft yellow sandstone	...	...	...	...	...	...	...	6	2
Shale and soft carbonaceous sandstone	...	...	...	...	...	...	...	8	0
Coarse gritty sandstone	...	...	...	...	...	...	...	10	0
								33	3

“Just a couple of hundred yards on the Maryborough side of the Copenhagen Bend, in a quarry, are showing thirty feet of grey sandstone, containing the ordinary fossils met with in these beds, and also numerous casts of *Belemnites*.\* Below this is a thin bed of carbonaceous sandstone, and below this again fifty feet of brown and grey sandstones (fossiliferous), dip 9° N. 35° E. Just in the centre of the bend, in a small gully cut into the steep bank of the river, are exposed:—

								Ft.	in.
Horizontal sandstone, consisting of small quartz crystals cemented together	...	...	...	...	...	...	...	16	0
Soft argillaceous sandstone...	...	...	...	...	...	...	...	9	0
Soft yellow sandstone	...	...	...	...	...	...	...	11	0
Grey shale and nodular carbonaceous sandstone	...	...	...	...	...	...	...	10	0
Black shales with bands of brown and grey sandstone...	...	...	...	...	...	...	...	11	0
								57	0

“These beds, it will be noticed, dip in the same direction, and have about the same angle of inclination as the coal-bearing beds of Saltwater Creek and the Burrum River; and as they are not seen again beyond this point, it is possible that there is a fault between them and the Burrum Series. Similar sandstones, too, with the characteristic fossils of the Maryborough Beds, are met with in the Isis River, about a quarter of a mile south-west of the Maryborough and Bundaberg Road, with a dip of from 30° to 45° to E. 40° N. These beds, which overlies the coal strata, can be traced for about a mile up a gully running into the Isis about half a mile higher up, but are not met with in the river again.

\* See Note under *Belemnites*, p. 574.

"I met with sandstone, belonging to the same series, containing the Cretaceous fossils *Avicula alata*, *Leda elongata*, and *Nucula*, &c., &c., about thirty-two miles north-west of Bundaberg, and about ten miles south of Rosedale Station. Their dip was uncertain, but they were evidently overlying the [Burrum] Coal Measures Series, which is exposed about two miles south, in Littabella Creek, dipping  $12^{\circ}$  to the N.E."

Mr. Rands writes me under date 16th September, 1889:—"I have come to the conclusion, after another examination, that the Maryborough Beds have been brought into their present position by a fault, and that they are unconformable with the Burrum Series, occupying some local hollow, as shown in the section." (Plate 46, fig. 3.)

Professor Ralph Tate, of Adelaide, after a careful study of the Organic Remains of the Cretaceous rocks of South Australia, records his opinion that the Maryborough Beds (Queensland) are of Cretaceous age.\*

In a Report on the "Geological Features and Mineral Resources of the Mackay District"† Mr. Maitland describes as follows certain "rocks probably the equivalent of the Desert Sandstone Series":—

"The rocks mapped as being the equivalents of the Desert Sandstone Series are classed with them more on account of their analogy to rocks of that age in widely separated localities than any stratigraphical or palæontological evidence collected would warrant. Nowhere are they seen to rest upon any rocks the relative age of which has been satisfactorily made out, and all that can be at present said of them is that they overlies unconformably all the other rocks of the district, save upon those referred to Post-Tertiary age.

"The strata consist of a series of trachytic lavas and subaqueous ashes, seen at several localities in the country to the north of the Pioneer, and about four hundred and fifty feet of sedimentary rocks, occurring in the cliffs forming the Cape Hillsborough tableland, and an isolated fragment of coarse conglomerate near Cape Palmerston.

"The lavas and ashes will be dealt with first, as in all probability they were formed in the early days of the history of this period.

"One of the most conspicuous examples of the lavas is to be found at Mount Mandarana, better known as the Black Gin's Leap, close to the Bowen Road, about twelve miles north-west of Mackay, where it forms a broad table-like mass, rising to a height of 650 feet, by corrected Aneroid, above the level of the road. The rock of which the Leap is made up is lithologically a trachyte, and may be generally described, when examined with a lens, or the unaided eye, as consisting of a light-coloured porous matrix, in which crystals of sanidine and minute crystals of what appear to be hornblende are embedded. It is seen (Plate 46, fig. 1) to rest upon black shales, at a point in a gully flowing from the north-west corner of the mountain three hundred feet above the road. At the junction of the two, the shales for a few inches are slightly hardened. The lower portion of the sheet is made up of rudely hexagonal curved columns, the outward curvature being northwards. The structure of certain parts of this rock would seem to imply that in reality it is a succession of lava-flows of variable thickness; the estimated thickness of the sheet is not less than three hundred and fifty feet.

"On the low hills on either side of the road, at no very great distance from the Leap Post Office, a bed of fine-grained, yellowish-white, ashy sandstone, with scarcely a trace of bedding, is seen to overlies the sandstones and shales. (Plate 46, fig. 1.) From

\* On the Age of the Mesozoic Rocks of the Lake Eyre Basin. *Proc. Austr. Assoc. Adv. Sci.*, i., 1888, p. 228.

† Brisbane: by Authority: 1889.

the similarity of the components of these sandstones to those of the Mandarana lavas, and their apparent unconformability to the underlying rocks, they are regarded as being subaqueous trachytic tuffs of the same age.

"Another fragment of rock of this class is seen capping the Finlayson Hills, twenty-two miles north-west of Mackay, and about a mile and a-half from the sea-coast, where it forms a sugarloaf-shaped peak, resting on granite, and rising to a height of about one hundred feet above the summit of the hills. (Plate 46, fig. 2.) This rock has a matrix of a purple-grey hue, with well-marked banded or ribboned structure, in which the lines of flows can often be seen to bend round the larger sanidine crystals embedded in the base. As a whole, the rock is much more compact than the Mandarana trachyte, and, like it, forms rudely hexagonal columns.

"On the eastern bank of the Victor Creek, in Selection 590 (Parish of Ossa), a well-marked escarpment of trachyte, forming McKenzie Crags, occurs. Here the lava rests upon the volcanic series.\* Several other isolated fragments occur near highwater mark at Rocky Bluff, about four and a-half miles south of Cape Hillsborough. Near the head of Niddoe's Creek, one of the watercourses draining the western side of that range of hills lying between the main range and the coast, a trachyte lava of a somewhat different character is seen, dipping south-east at an angle of  $12^\circ$ , and resting upon the sedimentary rocks of which this range is made up. Lithologically, the rock may be called a quartz-trachyte, and throughout it presents a great uniformity in its physical characters; it is made up of a light-grey porous matrix, in which quartz, sanidine, and small specks of what appear to be hornblende are embedded.

"In the Parish of St. Helens, on the south bank of Alligator Creek, a lofty range of mountains, the 'Pinnacles,' which form a 'corry,' encircling one of the branches of this creek, a great thickness of lava occurs. The rocks are trachytes of a brownish-grey colour, and with which fine-grained trachyte tuffs are associated. The lava sheets have their steeper faces southwards, and appear to dip in a general northerly direction.

"One of the sources from which some of these lavas and ashes have been ejected appears to be Mount Barren, a steep, triple-peaked mountain, the highest summit of which is about 2,000 feet above sea-level, and which is almost surrounded by the head waters of St. Helen's Creek. The rock of which this mass is made up is greyish-white in colour, and somewhat porous, with a mean specific gravity of 2.56. In the matrix small crystals of sanidine and minute specks of a black mineral—probably hornblende—can be recognised; throughout the whole of the mass the rock retains very much the same character. The mountain rises perpendicularly from the alluvial flat on the north bank of St. Helen's Creek, and in Barren Creek the mass is seen to be intrusive through an 'orthoclase porphyry,' upon which the sedimentary strata [of the Bowen River Series] are seen to rest. No perceptible amount of alteration was detected in any of the sections in which its intrusive character was observed.

"Another denuded wreck of an old volcano is to be found in Mount Jukes, some 1,800 feet above sea-level, and situated on the bank of Neilson's Creek, and about twenty miles distant from Mackay in a north-westerly direction. The mean specific gravity of the rock, from specimens in different parts of the mountain, was found to be 2.55. Different parts of the mass present different characters, but generally two varieties can be recognised:—

- (a) A coarse-grained rock in which a matrix can scarcely be said to exist, and
- (b) A second in which crystals of sanidine and plagioclase are embedded in a micro-crystalline base, which, with the aid of a lens, is seen to be made up of small crystals and crystalline grains of sanidine and hornblende (?).

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\* At the base of the Bowen River or Permo-Carboniferous Formation.

The former variety, owing to its coarse grain, would be called a nevadite, whilst the latter would be best described by the term sanidine trachyte: both, however, are merely varieties of one and the same rock. The rock is intrusive through the volcanic series, and sends out here and there dykes of no great thickness and of a somewhat similar character to the rock forming the main mass; hardly any apparent alteration has taken place in the rocks through which the mass has burst.

"On the north side of the Bowen Road, near its crossing of Murray Creek, a low hill opposite to Mount Ossa, known as Hammel's Hill, is found to consist at its base of a coarse volcanic ash or agglomerate, made up of trachytic materials, and above which a rock not unlike that forming the 'Sugarloaf' at Seaforth lies. This, seen in a bare scarp visible from the road, shows fluxion structure to the unaided eye, and in places fragments of the ash appear to have been caught up in the lava when in a molten condition, and dragged along with the viscid mass. The whole rock subsequently has been pierced by a fine-grained granite, and the agglomerate much altered, rendering it often, except on its weathered face, a matter of some difficulty to distinguish it from some forms of the lava beds.

"The Scrubby Hill, Mount Ossa, behind the house in Selection 1585 is, judging from the screes on its face, made up of a rock almost identical in physical characters with that forming McKenzie Crag.

"As a whole, these rocks bear a remarkable resemblance to those of Mount Britten. Some of the rocks there are very fine volcanic ashes, whilst others are true lavas. The 'Stalk,' a conspicuous pinnacle of rock on the divide between the waters of the Fitzroy and the Burdekin, 'possibly one of the vents from which the volcanic material of the bluffs in the neighbourhood of Mount Britten was ejected,'\* is almost identical with the trachytes of Mounts Barren and Jukes.

"The Mount Britten rocks have been conjectured by Mr. R. L. Jack to belong to the Desert Sandstone series, 'whose base is often made up of similar volcanic dust.' The Mount Funnel conglomerate, merely an outlier of this series, rests upon the altered grits and conglomerates of Carbonifero-Permian [Permo-Carboniferous] age, and is distant not less than forty-five miles from any rock its equivalent in age, and forms an impressive evidence of the power of denudation.

"The sedimentary rocks at Seaforth overlie a mass of porphyrite regarded as being newer than those of the 'Volcanic Series,' and which is well seen in a little bay at Cape Aberdeen, a mile to the south of Cape Hillsborough. Here the porphyrite is well seen in the cliffs at low water. It weathers into rude spheroidal masses, and where a freshly-broken surface is examined it is often found to be amygdaloidal, the greater part of the cavities being filled with carbonate of lime, though in some leucite can be detected.

"Overlying the porphyrite, a thickness of grits and fine conglomerate, and, in some places, nearly pure white and calcareous sandstones, occur. At one place directly overlying the porphyrite a bed of 'mudstone' is seen. Some little distance north this covers a great bank of conglomerate, which in turn is succeeded by the main mass of grits, &c.

"The Cape Table-land is made up of about four hundred and fifty feet of sedimentary materials, dipping at an angle of about 10° to W.S.W. The base consists of a thick mass of cavernous and ferruginous sandstones, succeeded by whitish conglomerates and breccias with thin beds of banded siliceous matter. Whether these

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\* Report by R.L.J. on the Geological Features of the Mackay District, p. 7. Brisbane: by Authority: 1887.



bands are formed by slow precipitation from springs charged with siliceous matter, or are beds of fine volcanic dust subsequently cemented, there is no evidence, at present, forthcoming to show. Hot springs are frequently met with in those districts where volcanic action is or has been rife; hence the siliceous bands occurring among the beds of the Cape may only be the indirect result of that activity which is conjectured to have taken place in the earlier stages of this period."

Mr. H. Y. L. Brown\* thus describes the Cretaceous rocks as seen by him between the 139th parallel and the Queensland Boundary from Lat. 26 to Lat. 32 S. :—

"The strata consist of brittle clays and calcareous shales, with bands of limestone and gypsum, clay, ironstone and ferruginous sandstone, and sandy beds; they are, as a rule, originally horizontal or gently undulating, and have a thickness, so far as at present known, of three hundred feet to four hundred feet. *Overlying this formation are beds of sandstone, argillaceous sandstone, kaolin, grit, and pebbly conglomerate, forming table-lands and hills almost invariably capped by a thin bed of yellow and red flinty quartzite or jasper-rock, the total thickness varying from one hundred to two hundred feet.* The pebbles found in this conglomerate consist of agate, jasper, chalcedony, opal, and coloured quartz, flint, white and crystallised quartz, and fossil wood showing a brilliant polish or glaze. The composition of these Supercretaceous beds is the same over wide areas, from the Warrego, in New South Wales, to the Diamantina. The topmost bed of yellow flinty quartzite or porcelainised sandstones, which forms the capping of the table-land formation, varies in thickness from ten to thirty feet; it has a conchoidal fracture, and sometimes shows an amorphous structure, at others encloses grains of sand or quartz pebbles (often coated by hyalite and opaline quartz), in which case it may be considered a conglomerate. This porcelainised rock is intensely hard, and its particles are at a tension; the most common appearance it presents is that of hard red or yellow boulders fitting close together, splintered, cracked and jointed into rounded and roughly prismatic shapes. It lies in patches on the argillaceous sandstones and clays, forming in some places a mere coating, in others a deposit of thirty or forty feet thick. Large and small cellular boulders and slag-like masses, with hollow stalactitic forms, are often found. Whether in masses or pebbles the rock is invariably glazed, so as to present a shining red or yellow surface. The most likely theory that can be advanced to account for the formation and glazed surface of this rock is that it has been formed by the infiltration of siliceous water from hot springs into beds of loose sand or porous sandstone. The stalactite-like forms of some of the specimens from Cooper's Creek, the occurrence of siliceous cores round nuclei of cemented sand in loose sand, and fragments of quartzite cemented together by silica, seem to prove this. The downs which flank the table-lands and hills are undulating and level plains, covered, as a rule, with a pavement-like coating of blocks or pebbles, or a red and yellow glazed porcelainised quartzite and flinty rock resting on soft yellow and reddish clayey loam; the glazing of these stones is also probably due to the action of siliceous water. The table-lands and hills composed of these Supercretaceous rocks are elevated to a height of some one hundred to two hundred and fifty feet above the level of the surrounding plains; though generally horizontal they are sometimes inclined at a low angle. On the Nilpie Nilpie Creek the flinty quartzite forms steep bluffs, and also occupies the creek-flat below, and undulates beneath the soft silt flats. . . . The elevated table-lands and hills occupy the country north and south of Cooper's Creek, in the vicinity of the eastern boundary line [of South Australia] to Haddon Station, near which place the range branches off eastward and northward into Queensland; Kirby's Knob, Mount

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\* Report of Government Geologist. Adelaide: by Authority: 1883.

Kingsmill, Edinboro' Castle, and Kertietia Hill being some of the chief points of elevation. The Grey Ranges of New South Wales and Queensland belong to the same formation.

"Overlying the Cretaceous and superincumbent hard rocks are deposits of loose and consolidated clay, loam, silt, sand, gypsum, limestone, &c., all of Tertiary and Recent age.

"Strewed over the surface of many of the plains and flat areas lie fragments of gravel, ferruginous sandstone and quartzite, with agates, chalcedony, and other pebbles derived from the table-hill formation, which prove the existence of these beds beneath the surface at no great depth."

It will be seen that Mr. Brown does not distinctly aver that the "Super-Cretaceous" rocks described by him lie unconformably on the Cretaceous; there can be no doubt, however, that he so understands their relations, as is evident from the sections accompanying the report. The identity of the "Super-Cretaceous" of South Australia with the Desert Sandstone of Queensland, in Mr. Brown's mind is settled by his remark that "the Grey Ranges of New South Wales and Queensland belong to the same formation." The "porcelainised" condition of a portion of the sandstone on the South Australian side of the border is a very interesting observation, in view of the "quasi-vitreous" appearance of the formation at Cloncurry and Croydon on the Queensland side. The superposition of Tertiary rocks on the Desert Sandstone of South Australia is an observation of the highest importance, as direct evidence of this nature is quite wanting in Queensland, and Daintree ascribed a Tertiary age to the Desert Sandstone itself.

Mr. Brown, in a Report to the Under Secretary for Mines of New South Wales, dated 17th Oct., 1881,\* observes that in the Mount Poole district [in the N.W. corner of New South Wales] the Cretaceous Formation "forms the undulating plains or downs of what was formerly known as the 'Stony Desert,' and is capped by the table-hills of the Grey and Mount Stewart Ranges, which rise in steep escarpments above it . . . Resting on the soft Cretaceous Formation, in outlying hills and tablelands, and in some cases covering it, over large areas, is a series of kaolin, sandstone, grit and pebble-conglomerate beds, capped by a layer of quartzite boulder-conglomerate, having often a slight dip in various directions, but being generally horizontal. The pebble-conglomerate is formed of large rounded boulders and pebbles of a yellow or reddish colour, together with yellow flint, quartz, &c., porcelainised in some way or other to an intense hardness, and bearing the appearance of having been fused. The total thickness from the bottom of the kaolin and sandstone to the top of the quartzite averages about one hundred feet. Mount Poole itself is an outlying mass of quartzite and flint conglomerate, forming a capping on ferruginous yellow and white sandstone resting on Cretaceous marly clay with gypsum; as also are The Turrets and other hills near. Near Whampa Waterhole, close to the 215-mile post on the N. S. Wales and Queensland boundary line, there is a section of about two hundred feet caused by the falling away of part of an isolated hill, as follows:—

- (1.) Hard flinty quartzite.
- (2.) White kaolin and sandstone, with veins of gypsum.
- (3.) Gray marly clay, with gypsum nodules.
- (4.) Yellow marly clay, with thin bands of clay iron ore.†

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\* Legislative Assembly Paper, N.S.W., 4th Nov., 1881.

† Nos. 3 and 4 probably in Cretaceous, and Nos. 1 and 2 in "Super-Cretaceous," according to Mr Brown, or Desert Sandstone according to Daintree's nomenclature.

"The continuation of the range whereof this hill is an outlier, extends northwards into Queensland and southward to Mount Stewart, and to the eastward of Milparinka. A portion of this range near Tipperberry Creek has a claystone-conglomerate instead of quartzite forming the capping of the hills, the lower beds being the same.

"At Mount Stewart the section is:—

	Ft.	in.
(1.) Quartzite conglomerate ... ..	10	0
(2.) Yellow sandstone, with grit and pebble conglomerate ...	20	0
(3.) White kaolin and sandstone ... ..	100	0
(4.) Pink " " " " " " " " }		
(5.) Gray marly clay, with iron ore and gypsum merging into the plains.*		

"The Grey Range enters Queensland about eight or ten miles to the west of Whampa, and is of the same formation but of larger extent than the last mentioned.

"On the top of one of these small tablelands, eight or ten miles south-west of Whampa, there is a grove of fossil tree-stumps standing in an upright position. There are thirteen or fourteen large ones, the greatest diameter being about four feet, and the height four and a-half feet. The woody portion is represented by a white quartz rock, and the bark by a brown quartzose sandstone and grit. Many of them are hollow, and fragments are lying about in all directions. Originally they must have been covered up, while erect, by a deposit of mud or other soft material like that on which they grew, and became petrified by the infiltration of silica and deposition of sand in their hollow portions; the matrix having since been denuded, they stand as evidences of how trees have degenerated in size in this part of the country since Cretaceous times.

"These hills extend a long distance westward and south-west. The Sisters, Mount Shannon, and many other flat-top hills, are of the same formation, which thins out to the south towards Mount Arrowsmith and the other outcrops of Silurian and Devonian rocks.

"Near Mullieo and Killara Run there is a section showing quartzite conglomerate on pebble conglomerate, with a deposit of chalky limestone conglomerate at the base of the hill, pieces of which, together with flint and chert, are contained in it. Quartzite conglomerate hills of low elevation extend from Mullieo to the Warrego, and up both sides of that river beyond Yantaballa on one side, and Shearers Springs on the other, into Queensland. What may be the geological age of those beds is not known, other than that they overlie deposits of Cretaceous age, as no fossils have been found in them. It is possible that they are upper beds of the Cretaceous period. They occupy the same position as the Queensland Desert Sandstone of Daintree, which has been lately proved by Mr. Jack, Government Geologist of Queensland, to be of Cretaceous age.

"Nearly the whole surface of the Downs country in the neighbourhood of Mount Poole, and particularly the soft Cretaceous plains, is covered with a layer of angular and rounded stones, consisting of quartz, slate, sandstone, limestone, flint, ironstone, trap, quartzite, jasper, chalcedony, gypsum, and fossil wood. Near the Silurian ranges these fragments are generally quartz and slate, directly derived from the ranges, while on the plains they are quartzite, sandstone, &c., derived from quartzite and sandstone conglomerate, which at one time covered this area, and of which the table hills and ranges alone remain.

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\* The dividing line between the Cretaceous and "Super-Cretaceous" rocks is probably the base of No. 4 in the above section.

In a "Report on a Journey from Adelaide to the Hale River" \* Mr. Brown refers to the prevalence of "Cretaceous clays and shales overlaid by sand and Super-Cretaceous rocks in the form of tablehills and tablelands" from Finnis Springs to Anna Creek, and from Anna Creek to Algebuckina on the Neales River. "From Mount Dutton northward to the vicinity of Mount Burrell, some two hundred and fifty miles, the whole country is occupied by the Cretaceous and Tertiary formations."

"The tableland, tablehill, sandhill, plain, and stony downs country presents a very similar aspect all over the area occupied by it. The jasper rock and porcelainite, or Desert Quartzite, forms the uppermost bed or capping of all, or nearly all, the flat-topped hills. This rock seems to have been formed by the infiltration of silica into the sands or sandstone and clay beds, which have been converted into jasper and porcelainite. The same will also occur in dykes in the sandstone and older rocks, and in many places has the appearance of having been deposited from springs. Travertine limestone and brown iron ore, which occurs as cappings to the flat-topped hills, and in large masses, have apparently been deposited in this way, as they can be seen directly connected with the present springs, although to a limited extent.

"Fragments of these rocks—viz., jasper, porcelainite, quartzite, and brown iron ore, together with flint, common opal, and opaline quartz—are scattered over the Cretaceous Clay plains and tablelands forming what are known as 'Stony Downs.' The sandstone forming the lower parts of the tablehills also contains pebbles and boulders of quartz, quartzite, and other waterworn siliceous pebbles, which are also in many places thickly scattered over the Plains. The thickness of these Super-Cretaceous (or Tertiary) rocks varies greatly. They become thicker in going north."

It will be noticed that the Writer now refers to the "Super-Cretaceous" as Tertiary.

Mr. Brown, in a "Report on the Country between Port Augusta and Eucla," † refers to "horizontal beds of Desert Quartzite, grit, conglomerate, sandstone, and kaolin, identical with the beds constituting the table-hills of the Cretaceous Formation," seen capping the lower portions of the granitic and metamorphic Warburton Ranges.‡

Between Kingoonya and Coondambo (north of Lake Gairdener) red loams and sandy plains alternate with stony downs and tablelands of desert quartzite.

Mr. Brown's latest views on the Desert Sandstone, as developed in South Australia, are given in a paper "On the Mesozoic Plains of South Australia, &c.," read in Section C, at the Sydney Meeting (1888) of the Australian Association for the Advancement of Science.§ After describing the "Lake Eyre Basin" and other regions consisting of the Rolling Downs Formation, Mr. Brown says:—

"The tableland and tablehill country occupy a large area in many places, as in the north-east corner of the colony. The general elevation above the plains is about one hundred to two hundred and fifty feet, the upper bed is almost invariably a yellow flinty jasper rock, or porcelainized sandstone and quartzite, varying in thickness up to thirty or forty feet. Sometimes it is a conglomerate, and at other times a sandstone. It rests on sandstone, argillaceous sandstone, kaolin, and grit, with thin bands of a loose pebble conglomerate. The pebbles found in the conglomerate consist of agate, jasper, chalcedony, opal, coloured quartz, flint, white and crystallized quartz, and fossil wood, all showing a brilliant polish or glaze.

"As these tablehills generally have sharp, well-defined cliffs and escarpments, the stratification can be easily studied. They are either of Upper Cretaceous or Lower Tertiary Age, and rest directly on the upper beds of the Cretaceous Formation, in horizontal and sometimes gently inclined layers; their composition and arrangement is

\* Adelaide: by Authority: 1889.

† South Australian Legislative Assembly Paper, 9th July, 1885.

‡ Approx. Lat. 30° 50' S.; Long. 134° 40' E.

§ Proc. Austr. Assoc. Adv. Sci., 1888, 1., p. 241.

the same over wide areas in South Australia, New South Wales, and Queensland, as far east as the Warrego River, where I have had an opportunity of examining them. The topmost bed of jasper rock has generally a conchoidal fracture and amorphous structure, although sometimes containing grains of sand and pebbles, and becoming a conglomerate; it also occurs as rounded fragments and pebbles of yellow jasper rock cemented together in masses with glazed surfaces.

"The Stony Downs are undulating and level plains, flanking the tablelands and extending for miles over the country, and covered with blocks and pebbles of the flinty jasper and other siliceous rocks, with sometimes vein quartz, slate, and sandstone; these fragments of rock are scattered over the surface of the plains and rest on soft yellow and reddish clay loam, derived from the denudation of the underlying shales. In many places the ground is covered with a smooth pavement-like covering of glazed fragments and pebbles, as in the Stony Desert of the Diamantina; in others the jasper rock lies scattered in slag-like masses and lumps on the soft loamy surface of the plains, together with gravel, shingle, and fragments of agate, chalcedony, quartz, flint, &c. It is difficult to account for the even distribution of these gravel and rock fragments over such a large extent of plain surfaces, floating ice being the only agent likely to produce such results. Below and surrounding the tablelands and stony downs are the soft silt plains, which, together with the former, cover the gypseous clays, marls, calcareous shales, limestone, sand, and gravel drifts of the Cretaceous age."

The late Rev. Julian E. Tenison Woods held that the Desert Sandstone was of sub-ærial or æolian origin, and was deposited in the position and at the levels at which it is now met with. In a Paper "On the Hawkesbury Sandstone," read before the Royal Society of New South Wales in 1882,\* speaking of the views of Messrs. Darwin, Daintree, Clarke, and Wilkinson, regarding the Hawkesbury Sandstone, but applying his remarks also to the Desert Sandstone of Queensland, Mr. Woods observed:—

"One fact seems to be lost sight of in all these theories, and that is that there has been no upheaval. The beds are horizontal in nearly every case, and there has been very little alteration of level since they were deposited. This is true wherever the formation is found, and it is a most significant fact connected with our eastern mountain range. The highest portions are recent volcanic, granitic, or horizontal sandstones, which have not been upheaved from the sea. There has been evident depression about such places as Sydney Harbour, but no elevation anywhere."

Again, in the same Paper, Mr. Woods observed:—"I do not think that the denudation [of the Desert Sandstone] has been very great, for most of these aerial hills were never united. It used to be the custom to refer the small horizontal caps and outliers on the tops of mountains to the remains of an enormous formation which had been denuded away. I myself thought this of O'Connor's Nob,† near Cooktown, and Mount Pigeonhouse, near Jervis Bay. Such stupendous denudation on horizontal strata, without any upheaval or subsidence, baffles comprehension; but when the aerial origin of these outliers is understood, the difficulty vanishes. There has been little or no denudation. The sandstone has been deposited just where it is found, and was never much larger than we see it now."

Had Mr. Woods lived to hear of Mr. Maitland's discoveries of an abundant and identical marine fauna found at high levels in the different fragmentary tablelands of Desert Sandstone, in the neighbourhood of Cooktown, I have no doubt that he would, with his well-known candour, have admitted the cogency of the evidence in favour of elevation.‡

\* Journ. R. Soc. N. S. Wales, 1882, xvi., p. 53.

† "Connor's Nob." (*R. L. J.*)

‡ I can testify that, during the severe illness from which he never recovered, Mr. Woods in a very great measure abandoned the æolian theory of the origin of the Hawkesbury and Desert Sandstones. (*R. E. Junr.*)

It may be noticed, from the first paragraph above quoted, that Mr. Woods appears to have confounded elevation with disturbance, or at least to have considered the one as necessarily accompanying the other. I fear that it will continue "to be the custom" to attribute such phenomena as Mr. Woods referred to, to elevation and subsequent denudation. So far from "such stupendous denudation on horizontal strata" baffling comprehension, the earth is so full of examples of the same kind, that they may be said to be part of the everyday experience of every geologist. It is only necessary to instance the Cañons of Colorado, the Felsenstadt in the Riesengebirge and the Blue Mountains of New South Wales, and I venture to say that most of my readers can supply other instances from their own observation.

The Upper Group of the Cretaceous Rocks, or Desert Sandstone, was, until recently, regarded as almost unfossiliferous. Organic remains appear to have been first found in these strata in 1872, by Mr. Norman Taylor, at Battle Camp, near Cobtown. In 1885, Mr. Warden Samwell collected fossils from the Desert Sandstone at Croydon, and subsequently the Writer made further collections from the same district. In 1890, Mr. A. Gibb Maitland discovered fossils in the Desert Sandstone near Battle Camp Range, on the Cooktown and Palmer Railway. But even of more importance than these is the history of the Maryborough Beds, which, formerly regarded only as a portion of the great Cretaceous Series, are now known to occupy a higher position, representing the Desert Sandstone of other parts of Queensland. The organic remains of the Desert Sandstone and Maryborough Beds, my Colleague says, "partake in a great measure of the *facies* of the Rolling Downs Formation, with an admixture of forms not hitherto recognised in the latter."

#### AGE OF THE DESERT SANDSTONE AND LIFE OF THE PERIOD.

The following is my Colleague's List of Fossils from this Formation. The different localities are denoted by initial letters, as follows:—

True Blue Hill, Croydon, T; Bett's Creek (Cape River), B; Mitchell River, MB; Mount Angus, Croydon, A; Maryborough, M; Mullet Creek, MC; Isis River, I; the first four localities being in the Desert Sandstone proper, and the last three in the Maryborough Beds.

PLANTÆ.							
ACOTYLEDONES.							
<i>Didymosorus ? gleichenioides</i> , Oldham				<i>Maccoyella ? umbonalis</i> , Moore	...		M
and Morris	...	...	T	<i>Cucullæa robusta</i> , Eth.	...	...	M
<i>Glossopteris</i> , sps.	...	...	B, MB	<i>Nucula quadrata</i> , Eth.	...	...	M
				" <i>gigantea</i> , Eth.	...	...	M, MC
				<i>Nuculana</i> (? <i>Yoldia</i> ) <i>Randsi</i> , Eth.	fl.	...	I
				<i>Adrana elongata</i> , Eth.	...	...	M
				<i>Trigonia nasuta</i> , Eth.	...	...	M
				" <i>sp. ind.</i> (a.) (Pl. 26, fig. 5)	...	...	M
				<i>Cyprina Clarkei</i> , Moore	...	...	M
				<i>Unicardium ? Etheridgei</i> , Eth.	fl.	...	M
				<i>Palæomara mariaeburiensis</i> , Eth.	...	...	M
				" ? <i>sp. ind.</i> (Pl. 26, fig. 17)	...	...	M
				<i>Glycimeris sulcata</i> , Eth.	...	...	M
				" <i>rugosa</i> , Moore	...	...	M
				<i>Ceromya ? sp. ind.</i> (Pl. 26, fig. 20)	...	...	M
				<i>Lutraria</i> , <i>sp. ind.</i>	...	...	M
				<i>Teredo</i> , <i>sp. ind.</i> (Pl. 43, figs. 11 and 12)	...	...	T
ANIMALIA.							
ECHINOIDEA.							
<i>Micraster Sweeti</i> , Eth. fl.	...	...	M				
BRACHIOPODA.							
<i>Rhynchonella croydonensis</i> , Eth. fl.	...	T, A					
PELECYPODA.							
<i>Ostrea</i> , <i>sp. ind.</i> (Pl. 43, fig. 8)	...	T					
<i>Placuna</i> , <i>sp. ind.</i> (Pl. 43, fig. 9)	...	T					
<i>Lima</i> ( <i>Radula</i> ) <i>Randsi</i> , Eth. fl.	...	M, MC					
" <i>sp.</i> (Pl. 21, Fig. 11)	...	I					
<i>Pseudavicula, alata</i> , Eth.	...	M					
<i>Maccoyella Barklyi</i> , var. <i>mariaeburiensis</i> ,							
Eth. fl.	...	T					
" <i>corbiensis</i> , Moore	...	M					
" <i>reflecta</i> , Moore	...	I					
" ? <i>substriata</i> , Moore	...	M					
				GASTEROPODA.			
				<i>Siphonaria Samwelli</i> , Eth. fl.	...	T	
				<i>Natica variabilis</i> , Moore	...	M	
				CEPHALOPODA.			
				<i>Belemnites</i> , <i>sp.</i>	...	M	

To the foregoing list there are to be added the fossils from the Cooktown and Palmer Railway, collected by Mr. Maitland, as already mentioned. Mr. Maitland refers\* to *Maccoyella*? and *Rhynchonella*, but the collection has not yet been examined by my Colleague, and so far as we know, adds no new species to the Desert Sandstone list.

Of the above, the following species of Pelecypoda are common to the Desert Sandstone (including the Maryborough Beds) and Rolling Downs Formations; *Maccoyella Barklyi*, *M. reflecta*, *M. umbonalis*, *M. corbiensis*, *M. substriata*, *Nucula quadrata*, *Cyprina Clarkei*, and *Glycimeris rugosa*, and also the Gasteropod *Natica variabilis*, and the following genera—*Rhynchonella*, *Ostrea*, *Lima*, *Pseudavicula*, *Maccoyella*, *Cucullæa*, *Nucula*, *Trigonia*, *Cyprina*, *Palæomæra*, *Glycimeris*, *Pecten*, *Natica*, and *Belemenites*; so that a strong case can be made out in favour of a connection between the Rolling Downs and Desert Sandstone. It must, however, be remembered that the original fossils from Wallumbilla, Mount Abundance, and Mount Corby, upon which several of the above identifications rest, were collected without any idea that a distinction could be made between the Desert Sandstone tablelands and the underlying Rolling Downs Formation. It is just possible, therefore, that some of the fossils quoted as belonging to the Rolling Downs ought to be credited to the Desert Sandstone.

In the above list we have an assemblage of fossils of decidedly Cretaceous types, and possessing much in common with the Rolling Downs Formation. We may therefore with safety separate the Cretaceous rocks met with in Queensland into a Lower and Upper Series, the latter being our Desert Sandstone, which is separated from the Rolling Downs Formation by an unmistakable unconformability. At the time when Mr. Daintree and Mr. R. Etheridge, F.R.S., wrote their Papers on the Geology and Palæontology of Queensland (1872), no determinable fossils had as yet been obtained from the Desert Sandstone, but the Maryborough Beds had yielded a considerable number, on the strength of which Mr. Etheridge placed the latter *beneath* the Hughenden and Marathon beds. We now unite the Desert Sandstone and Maryborough Beds, on the ground of the similarity of their organic remains, and the Desert Sandstone has been observed to rest unconformably on the Hughenden Beds. Taking this break into consideration, Daintree regarded the Desert Sandstone as Tertiary. The fossils which, in the last few years, have been discovered in the Desert Sandstone at Croydon and Cooktown show that the formation has much in common with the Rolling Downs or Lower Cretaceous, and nothing in common with the Tertiary. Lithologically it has always seemed to me that the well-consolidated and occasionally quasi-vitrified or porcellanised strata of the Desert Sandstone were singularly unlike any of the comparatively loose and unconsolidated deposits ascribed in Australia to the Tertiary age. The late Rev. J. E. Tenison Woods even went so far at one time as to regard the Desert Sandstone, on the ground of lithological similarity, as the equivalent of the Hawkesbury Sandstone—which, however, is quite untenable in the face of the fact that it is newer than the Lower Cretaceous. Lithological resemblance in such a case does not count for much, as one siliceous sandstone is very like another, whatever may have been the date of its deposition.

#### MINES CONNECTED WITH THE DESERT SANDSTONE.

The presence of coal in the Desert Sandstone is now well known. In a previous portion of this chapter descriptions of the coal at Cooktown and in the Cape York Peninsula have been given.

Speculations as to the existence of deep auriferous leads beneath the Desert Sandstone will be found on page 539.

\* And in all probability correctly so. (R.E. Junr.)

Opals and other precious stones form at present the chief mineral wealth of the formation.

The opals are found in nodules of ferruginous siliceous sandstone and siliceous ironstone, either in the "Desert Sandstone" or denuded out of it, and lying on the surface of the underlying "Rolling Downs" formation.

From the following places valuable opals have been obtained :—

				S. Lat.	°	'		E. Long.	°	'
Pleasant Creek	...	...	...	25	23	...		145	15	
Bulgroo and Kyabra Creek	...		...	"	25 50	...	"	143	35	
Costello's Creek	...	...	...	"	25 57	...	"	142	47	
Mayne River	...	...	...	"	23 32	...	"	141	32	
Nickavilla	...	...	...	"	26 20	...	"	144	20	
Winton	...	...	...	"	22 32	...	"	143	12	
Boulia	...	...	...	"	22 55	...	"	143	0	

**J.**



## CHAPTER XXXIV.

### THE ORGANIC REMAINS OF THE DESERT SANDSTONE FORMATION (UPPER CRETACEOUS), WITH DESCRIPTIONS OF THE SPECIES.

#### Kingdom—PLANTÆ.

#### Section—CRYPTOGAMIÆ.

#### CLASS—ACOTYLEDONES.

#### Order—FILICES.

#### Family—GLEICHENIACEÆ.

*Genus*—*DIDYMOSORUS*, *Debey and Ettingshausen*, 1859.

(Denk. K. K. Akad. Wissensch. Wien, xvii., 1 Abth., p. 186.)

*DIDYMOSORUS* ? *GLEICHENIOIDES*, *Oldham and Morris*, var.

*Pecopteris* (*Gleichenites*) *linearis*, O. and M., Mem. Geol. Survey India, ii., p. 324.

„ „ *gleichenioides*, O. and M., Pal. Indica (Gondwana Flora), 1862, i., Pt. 1, p. 45, t. 25, t. 26, f. 1, 3.

*Gleichenites* (*Gleichenia*) *bindrabunensis*, Feistmantel, *Ibid.*, p. 93.

*Gleichenia bindrabunensis*, Schimper, *Traité Pal. Vég.*, 1869, ii., p. 670.

*Didymosorus* ? *gleichenioides*, Etheridge fil., Proc. Linn. Soc. N. S. Wales, 1888, iii., Pt. 3, p. 1308, t. 38, f. 3.

*Sp. Char.* Frond [bipinnate] long, narrow, parallel-sided, tapering but very slowly. Pinnæ long and linear, opposite or sub-alternate, rarely alternate, obtusely pointed at their apices, springing from the rachis at right angles, and in close contiguity to one another. Rachis straight, non-flexuous, small and delicate. Pinnules short, entire, broad-ovate, sub-alternate on the pinnæ, and decurrent.

*Obs.* The present plant is, I believe, identical with the *Pecopteris gleichenioides*, Oldham and Morris, which should be placed in the genus *Didymosorus*, Debey and Ettingshausen,\* one of the Gleicheniaceæ. This genus resembles the recent *Gleichenia* but possesses a different fructification. The frond in *Didymosorus* is dichotomous and bipinnate, each division being very long, narrow, and nearly parallel-sided; the pinnæ are quite linear, either opposite, or sub-alternate, on a very narrow rachis.

The typical species of *Didymosorus*, *D. comptonifolia*, D. and E., occurs in the Cretaceous rocks of Aix-la-Chapelle, whilst *Pecopteris gleichenioides* is found in the Mesozoic rocks of the Rajmahal Series of India.

The Australian plant corresponds with the description of the genus in every particular, but we do not possess enough of the frond to show dichotomisation. It is either identical with the Indian species, or a mere variety of it, although it has points in common with the European form. Unfortunately for the purposes of strict identification, the specimens are preserved in a fine siliceous grit, which has obliterated all evidence of fructification, if any such existed, and also of the nervation. As regards size the

\* Denks. K. Akad. Wissensch. Wien, 1859, xvii., 1 Abth., p. 186.

specimens now under description agree entirely with the Indian species, but seem to be rather smaller than the European, the general width of a pinna being two-sixteenths of an inch.

The figures of Oldham and Morris\* represent portions of fronds as long as seven inches, and two and a-half inches wide, but the largest of our specimens is four inches long and one and a-quarter wide. The pinnæ are certainly narrower than *D. gleichenioides*, but as this point may entirely depend on the position occupied by the specimen in the frond, it cannot be taken as a point of much importance.

As no fructification has been seen, it would perhaps be more advisable to place the Croydon fossils, "characterised by the slenderness of the whole leaf, and by the delicate linear form of the pinnæ" (Feistmantel), in *Gleichenites*, as Oldham and Morris have done with their species; although, be it noted, they refer to the general resemblance of the latter to *Didymosorus*. On the other hand, so close a resemblance can hardly have existed without some corresponding affinity in the productive state, and I shall therefore venture to place *Gleichenites gleichenioides* in *Didymosorus*, and provisionally refer the Australian form to it.

The general relations of this peculiar fern have been ably discussed by the late Messrs. Oldham and Morris; but in their description they state the pinnæ are alternate. Their figures, however, show as much variation from alternate to opposite as do our specimens. At the same time the pinnæ are apparently closer in the Indian fossils.

The small ovately-pointed pinnules, entirely decurrent as they are, give to the pinnæ a fret-saw-like appearance, and are evidently a very characteristic feature of the fern. In consequence of the gritty nature of the matrix the venation is obscure, but Oldham and Morris say generally—"The nervation of the pinnules is very indistinct, but seems to consist of a small flexuous midrib becoming nearly obsolete at the end of the pinnules, and from which secondary veins pass off obliquely at irregular intervals."†

*Loc. and Horizon.* True Blue Hill, Croydon Gold Field, North Queensland (*E. L. Jack*).

#### Family—DICTYOTÆNIOPTERIDÆ.

*Genus*—*GLOSSOPTERIS*, *Brongniart*, 1828.

(*Prodrome Hist. Vég. Foss.*, p. 54.)

*Obs.* The discovery of this genus by Mr. W. H. Rands, in beds believed to be of the age of the Desert Sandstone, has already been referred to.‡ That the plant-remains so discovered are portions of the fronds of *Glossopteris* is unquestionable. The majority I am simply unable to distinguish from *G. Browniana*, Brong., two at least possessing the broad striated midrib represented in some of Dr. O. Feistmantel's figures.§ With these are portions of two other very large fronds, with fine close veins, which stream out at a very low angle from the midrib, producing a long, narrow mesh, and recall to mind the appearance of *G. tæniopteroides*, Feist.,|| and *G. ampla*, Dana.¶ The large size that these leaves unquestionably attained indicate the latter species as that to which they are more nearly allied. It will be remembered that both *G. Browniana* and *G. ampla* occur in the Bowen River Series of the Permo-Carboniferous.\*\*

\* *Pal. Indica* (Gondwana Flora), 1860, i., Pt. 1, fas. 6, p. 45, t. 25, f. 2 and 3.

† *Loc. cit.*, p. 46.

‡ See pp. 169 and 193.

§ *Mem. Geol. Survey N. S. Wales*, Pal. No. 3, 1890, t. 17, f. 1, 1a.

|| *Ibid.*, t. 18, f. 1, 1a.

¶ *Ibid.*, t. 19, f. 1 and 2.

\*\* See pp. 193 and 195.

This is the first occasion on which *Glossopteris* has been found in Australia outside beds of Permo-Carboniferous age, *i.e.*, beds which could be shown so to be by the associated fossils. Hitherto, the occurrence of *Glossopteris* in our Palæozoic, and *Taniopteris* in the Mesozoic strata, has been regarded as an article of faith, the first never having been, to my knowledge, found above the Upper Coal Measures, and the second plant below the Clarence Series. So long has this stood the test of inquiry in the field, and so closely do the leaves found by Mr. Rands correspond to two of our most characteristic Permo-Carboniferous species of *Glossopteris*, that were it not for a personal knowledge of the extreme care and wide stratigraphical experience of my Colleague and his Assistant, I should be tempted to question the reference of the beds yielding these leaves to the Desert Sandstone Series. It must, at any rate, be regarded as a very remarkable survival. In India, it is true, *Glossopteris* passes, according to the stratigraphy of the late Dr. O. Feistmantel, into the Trias,\* and the same appears to be the case in South Africa. There the upward course of *Glossopteris*, with any certainty, appears to cease, according to our previous knowledge of its range in time; for although a species has been described by Prof. Trautschold from the Russian Cretaceous, and by Messrs. Visiani and Massalongo from the Italian Tertiary,† still, these determinations require confirmation. Perhaps the present instance may to some extent supply this.

Mr. Norman Taylor, when acting as Geologist to W. Hann's "Expedition in Northern Queensland," as long ago as 1872, found *Glossopteris* in a tableland between the Mitchell and Walsh Rivers, to which he in consequence ascribed, and with our then knowledge justly so, a Carboniferous age, and it became known as "Taylor's Carboniferous Range."‡ The tableland in question, however, according to my Colleague, is a denuded fragment of the Desert Sandstone, and Mr. Taylor's fossils must in consequence be added to the list of the Desert Sandstone Flora.

*Loc.* Tableland south of Mitchell River (*N. Taylor*); Bett's Creek, near Cape Gold Field (*W. H. Rands*—Colln. Geol. Survey, Queensland).

## Kingdom—ANIMALIA.

### Sub-Kingdom—ECHINODERMATA.

#### Class—ECHINOIDEA.

#### Order—EUECHINOIDEA.

#### Section—REGULARES (Endocyclica).

#### Family—SPATANGIDÆ.

#### *Genus*—MICRASTER, *Agassiz*, 1834.

(Prod. Mon. Rad. Echinod.)

#### MICRASTER SWEETI, *sp. nov.*

*Obs.* It affords me much pleasure to associate with this, the first Mesozoic Echinoderm described from Australian rocks, the name of my friend Mr. George Sweet, of Brunswick, Melbourne, who has worked with much success amongst the fossiliferous rocks of Eastern Australia, and to whom I am indebted for the contribution of a large number of specimens.

\* Mem. Geol. Survey N. S. Wales, Pal. No. 3, 1890, p. 119.

† Feistmantel, *loc. cit.*, pp. 119, 120.

‡ Proc. R. Geogr. Soc., 1874, xviii., p. 92.

Two previous but indefinite records of Cretaceous Echini have been made. In 1860, Dr. A. R. C. Selwyn wrote\*: "I have lately discovered, embedded in our Pliocene water-worn gravel, near Melbourne, two specimens, considered by McCoy to belong to decidedly Chalk species. One is a very perfect Echinoderm, the other a fragment of a Coral." Such specimens have never been described by Prof. McCoy, but he has referred to them in very emphatic terms in his Paper "On the Discovery of Cretaceous Fossils in Australia," wherein he remarks†: "Mr. Selwyn also alluded formerly to a specimen of an Echinide in flint given to him as found in sinking a well at Prahran, near Melbourne, having been identified by Prof. McCoy as the European Cretaceous *Conulus albogalerus*. The Author had also a flint *Ananchytes oratus* of the same age, given to him as found at Richmond, near Melbourne, also; but he considered both these specimens were unsatisfactory as far as the proof of their having really belonged to any Australian stratum." Nor is any reference made to these species in Prof. McCoy's second Essay "On the Recent Zoology and Palæontology of Victoria,"‡ under the section, "Cretaceous Period."

The second reference is to a remark of the late Mr. Charles Moore, who, speaking of a collection of West Australian fossils on view at an Exhibition, says§: "In addition . . . there was a silicious cast of a *Micraster* from the Chalk." So far as I am aware, no further steps have been taken to test the occurrence of this genus in West Australia.

Few absolute particulars can be obtained from the present specimen, I regret to say, from its bad state of preservation, beyond the fact that it is one of the Spatangidæ, and probably referable to *Micraster*, but as neither the fascioles nor tubercles are visible, the reference to this genus is even questionable.

The test, in its present state, is two inches long from anterior to posterior, and one and a-half inches wide. It is spatangoid in outline, with petaloid ambulacra, the anterior pair much the longest, odd or anterior ambulacrum reposing in the sulcus, which evidently indented the anterior border. The specimen is a cast, the test having been entirely removed. The whole of the abactinial surface is concealed in immovable matrix. It will be subsequently figured.

*Loc.* Corporation Quarry, Maryborough (*G. Sweet*—Colln. Sweet, Melbourne).

## Sub-Kingdom—MOLLUSCA.

### Section—MOLLUSCOIDA.

#### Class—BRACHIOPODA.

#### Order—TRETENTERATA.

#### Family—RHYNCHONELLIDÆ.

*Genus*—*RHYNCHONELLA*, Fischer, 1809.

(Notice Foss. Gouv. Moscou, p. 35.)

*RHYNCHONELLA CROYDONENSIS*, *sp. nov.*, Pl. 41, figs. 13 and 14.

*Sp. Char.* Shell moderately transversely elongated, wider than high, feebly convex, and sometimes attaining rather large proportions; cardinal margin angular; front faintly sinuated. Ventral valve with a wide shallow sinus, and the flanks to some

\* Quart. Journ. Geol. Soc., 1860, xvi., p. 148.

† Trans. R. Soc. Vict., 1866, vii., p. 50.

‡ Ann. and Mag. Nat. Hist., 1867, xx., p. 195.

§ Quart. Journ. Geol. Soc., 1870, xxvi., p. 227.

degree flattened; umbo sharp and projecting; dental plates, as indicated by the impressions left, strong, short, and rather curved; flanks bearing six prominent angular ribs, and the sulcus occupied by four fainter costæ, with indistinct traces of distant transverse lamellæ. Dorsal valve depressed, with a faint flat fold; septum very short; costæ similar to those of the ventral valve.

*Obs.* This *Rhynchonella* is common in the Croydon Grit, but always in the form of casts, and those usually of the ventral valve. At first sight it would appear to have some resemblance to *R. lacunosa*, Schl., from the White Jura of Germany, although the outline is decidedly more than that of *R. compressa*, Sby., of the European Cretaceous, but the costæ in our shell are too few and coarse for that species. With the exception of the inequilateral feature in *Rhynchonella asteriana*, D'Orb., our shell comes very close to this. The specimens are not large for a Jurassic *Rhynchonella*, but they are so as compared with the generality of the Cretaceous forms, and when compared with Tertiary or Recent species are very large.

Another shell allied to *R. croydonensis* is *R. major*, J. de C. Sby., sp.,\* from the Upper Mesozoic Beds of Cutch, but the costæ are far too numerous and close.

Associated with *R. croydonensis* is a smaller cast, apparently that of a dorsal valve. It possesses a much more regular degree of convexity, and is without a mesial fold, but there is present the same flattened umbonal region as in the above. Its more convex form generally and the want of a fold forbids it being the dorsal valve of *R. croydonensis*, but at the same time the two forms do bear an indescribable resemblance to one another. As in the former case, the septum is short (Pl. 42, fig. 8).

*Loc.* True Blue Hill, Croydon Gold Field (*R. L. Jack*); Mount Angus, Croydon (*R. L. Jack*).

## Section—MOLLUSCA VERA.

### Class—PELECYPODA.

### Order—OSTRACEA.

### Family—OSTREIDÆ.

### Genus—OSTREA, Linnæus, 1758.

(Syst. Nat., Ed. x., p. 696.)

### OSTREA, *sp. ind.*, Pl. 43, fig. 8.

*Obs.* Some obscure impressions and casts from the Croydon Grit appear referable to this protean and widely spread genus. It is difficult to assign any definite characters to them, but the casts are irregularly sub-obovate, oblique to some extent, not greatly widening towards the front. The umbo of the under valve is thickened although not curved upwards, but the left-hand edge or margin of the shell deeply sinuated. The grooved cartilage area is roughly triangular, and obliquely inclined towards the sinuated side.

This resembles many forms of Oyster, but is not unlike a variety of *Ostrea patina*, which the late Mr. Meek proposed to call *Ostrea subsinuata*,† except that the sinuated margin is on the right side of the attached valve; in our specimens it seems to be on the left. In addition to this the ligamental depression is oblique, but in Meek's figure it is not so represented.

There is not sufficient evidence to warrant a specific name being given to these specimens.

*Loc.* True Blue Hill, Croydon Gold Field (*W. Samwell*).

\* Trans. Geol. Soc., 2nd Ser., v., Expl. t. 22, t. 22, f. 16.

† Report U. S. Geol. Survey Ter., 1876, ix. (Invert. Cret. Tert. Foss. Up. Missouri), p. 18, t. 11, f. 4a and 4b.

## Family—ANOMIIDÆ.

Genus—*PLACUNA*, Bruguière, 1789.

(Encycl. Méthod., i.)

*PLACUNA*, *sp. ind.*, Pl. 43, fig. 9.

*Obs.* The presence of the genus *Placuna* in the uppermost Mesozoic Beds of Queensland is shown by the occurrence of a small shell, one and a-quarter inch wide by the same in height, with a nearly straight cardinal margin. The specimen is only an impression, possibly of the interior of the right valve, and shows the indentations left by its own diverging teeth, and the impressions of the teeth of the opposite valve. There are also traces of the shoehorn-shaped muscular impression, but there is no sign of any pit between the "cartilage fulera."

The transverse outline of this species renders it a peculiar one, as it is more or less equal to the vertical measurement.

*Loc.* True Blue Hill, Croydon Gold Field (*R. L. Jack*).

## Family—LIMIDÆ.

Genus—*LIMA*, Bruguière, 1789.

(Tab. Encycl. Méthod., Pl. 206.)

*LIMA* (*RADULA*) *RANDSI*, *sp. nov.*, Pl. 21, fig. 13.

*Sp. Char.* Shell obliquely ovate, more or less compressed, very slightly alate posteriorly. Hinge-line very short, straight, and horizontal. Anterior side rounded, alate above, margin convex; posterior side small, very slightly alate, with a convex margin, slightly emarginate above; posterior slope sharp; ventral margin obliquely rounded. Umbones moderately acute, apparently incurved. Surface bearing as many as fifteen (twelve to fifteen) broad, to some extent flattened, radiating ribs, with at times traces of a few shorter interpolated costæ, separated by flat interspaces, considerably wider than the width of the ribs, crossed by delicate concentric lamellæ; the anterior and posterior wings, and the sides of the valves contiguous to them, are devoid of ribs.

*Obs.* This shell, although allied to *Lima Gordoni* (Pl. 24, fig. 16), is believed to be distinct. The costæ of the former are much more numerous, the margins of the shell are quite differently curved, and there does not appear to be any pronounced hinge-line. *L. Gordoni* is also much more obliquely produced towards the posterior side. A fragment of another specimen would seem to show that some of the ribs on the anterior side were spinous at their front edges.

From the shell I have called *Oxytoma rockwoodensis* (Pl. 24, fig. 15) the present differs in a less convexity, altogether different posterior wing and umbo, and by possessing radiating ribs thicker and more obtuse. Our species resembles a shell figured by Conrad as *Lima leonensis*,\* but is less oblique.

Named in honour of Mr. W. H. Rands, Assistant Government Geologist of Queensland.

*Loc.* Near Mullet Creek, twelve miles south of Rosedale Station, Port Curtis (*W. H. Rands*); Corporation Quarry, Maryborough (*W. H. Rands*; *G. Sweet*—Colln. Sweet, Melbourne; and *T. W. E. David*—Colln. David, Sydney).

\* Descrip. Cret. and Tert. Foss. Report U.S. and Mexican Boundary Survey, 1857, i., Pt. 2, p. 151, t. 5, f. 3a-c.

LIMA, *sp.*

Pl. 21, fig. 11.

*Obs.* A shell allied to this genus is perhaps represented in the ill-preserved example represented in Pl. 21, fig. 11. The hinge has disappeared, but a small portion of one of the ears remains. The exterior, as seen through the thin shell, is highly cancellate, resembling that of *Pecten æquilineatus*, Moore (Pl. 21, fig. 10).

*Loc.* Isis River, near Bundaberg, and Maryborough Road (*W. H. Rands*).

## Order—MYTILACEA.

## Family—AVICULIDÆ.

Genus—PSEUDAVICULA, *Etheridge fil.*

(See p. 449.)

*Obs.* A description of this new genus comes more conveniently under the head of "Rolling Downs Fossils," to which the reader is referred.

PSEUDAVICULA ? ALATA, *Etheridge, sp.*, Pl. 24, fig. 14.

*Avicula alata*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 342, t. 20, f. 8.

*Sp. Char.* Shell inequivalve, inequilateral; auricles unequal, posterior much expanded, anterior small; hinge-line straight, umbones acute and prominent, umbonal region thick; valves with numerous (thirty-four) radiating ribs, with alternating smaller ones, except near the middle of the valve, where the ribs (seven and eight) are all equal, and range from the umbo to the ventral margin. (*Etheridge.*)

*Obs.* The generic affinities of this species are at present very obscure. It is not an *Avicula*, but may have relations with the present genus.

*Loc.* Maryborough (*The late R. Daintree*).

Genus—MACCOYELLA, *Etheridge fil.*

(See p. 451.)

MACCOYELLA BARKLYI, *var. MARLBURIENSIS, Etheridge fil.*

Pl. 22, fig. 3; Pl. 42, figs. 4 and 5.

(For synonymy and description, see p. 455.)

*Obs.* The species will be found fully described amongst the Rolling Downs fossils; \* particular attention, however, may be called to Pl. 22, fig. 3, which seems to be distinguished by the size and rugosity of the primary costæ, and development of the posterior spines. It is particularly characteristic of the Desert Sandstone Beds. Other figures are given, Pl. 42, figs. 4 and 5, of specimens from Croydon.

*Loc.* Spring and True Blue Hills, Croydon Gold Field (*R. L. Jack and W. Samwell*). Occurs also in the Rolling Downs Beds.

MACCOYELLA CORBIENSIS, *Moore, sp.*

Pl. 22, figs. 8 and 9.

*Avicula corbiensis*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 246, t. 11, f. 7.

*Crenatula ? gibbosa*, Etheridge, *Ibid.*, 1872, xxviii., p. 339, t. 19, f. 3.

*Obs.* *M. corbiensis* has been fully described under the "Rolling Downs" section from specimens in the combined Collections of the Geological Survey and Messrs. Tate, Sweet, and David. It is a particularly characteristic fossil of the Maryborough Beds.

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\* See p. 455, Pl. 22, figs. 1-5, Pl. 23, figs. 1 and 2.

*Loc.* Corporation Quarry, Maryborough (*R. L. Jack*; *G. Sweet*—Colln. Sweet, Melbourne; *T. W. E. David*—Colln. David, Sydney). Occurs also in the Rolling Downs Beds.

*MACCOYELLA REFLECTA*, *Moore*, sp.

Pl. 23, figs. 3-7 and 10; ? figs. 1 and 2.

*Avicula reflecta*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 246, t. 12, f. 1.

„ *Barklyi*, var. *reflecta*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 2, p. 240, t. 12, figs. 4-6.

*Obs.* This species is described under the head of “Rolling Downs,” to which the Reader is referred.\* It has been found in the Desert Sandstone at the following locality:—

*Loc.* Isis River, near Maryborough and Bundaberg Road (*W. H. Rands*). Occurs also in the Rolling Downs Beds.

*MACCOYELLA ? SUBSTRIATA*, *Moore*, sp.

Pl. 23, figs. 8 and 9.

*Avicula substriata*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 247, t. 11, f. 6.

*Obs.* As in the case of the other species of *Maccoyella*, this is described amongst the Rolling Downs Mollusca.† The shells figured (Pl. 23, figs. 8 and 9) are believed to appertain to the present species. The reference is chiefly made on account of the extended posterior wing, but this is accompanied by a peculiar elevation of the hinge or dorsal margin at its outward termination. The specimen is in a poor state of preservation, so that a definite opinion may be for the present held over.

Both figs. 8 and 9 occur in close contiguity on the same piece of matrix, and are probably the right and left valves of the same species. They are but casts. Fig. 9 is a convex valve, and more or less oblique, bearing thirteen or more strong ribs. The cardinal margin is long, and produced upwards, forming with the posterior end a high elevated wing. The whole length of the cardinal margin is bordered by a small longitudinally grooved area, not shown in the figure. The subject of fig. 8 is a flatter valve than fig. 9, with finer and much more numerous ribs, and in addition interpolated riblets, with the interspaces cross-striated.

*Loc.* Maryborough (*R. L. Jack*). Occurs also in the Rolling Downs Beds.

*MACCOYELLA ? UMBONALIS*, *Moore*, sp.

Pl. 23, fig. 4.

*Avicula umbonalis*, Moore, Quart. Journ. Geol. Soc., 1870, xxvi., p. 246, t. 12, figs. 2 and 3.

*Obs.* This species is fully described under the head of “Rolling Downs,” to which the Reader is referred.‡

I have not seen a perfect specimen of this species, but Mr. Rands has collected a large bivalve at Maryborough which has some resemblance to Moore's figure. It is transversely ovate, with an obtuse umbo, and a sharp, incurved beak. A large number of radiating ribs were present, some being larger and more determinate than the others.

*Loc. and Horizon.* Corporation Quarries, Maryborough (*W. H. Rands*; *G. Sweet*—Colln. Sweet, Melbourne); Wharf Railway, Maryborough (*W. H. Rands*). Occurs also in the Rolling Downs Beds.

\* See p. 457, Pl. 23, figs. 1, 2, 3-7, and 10.

† See p. 459, Pl. 22, fig. 10.

‡ See p. 458, Pl. 22, figs. 6 and 7.



## Order—ARCACEA.

## Family—ARCIDÆ.

Genus—*CUCULLÆA*, Lamarck, 1801.

(Syst. Anim. sans Vertéb., p. 116.)

*CUCULLÆA ROBUSTA*, Etheridge, Pl. 26, figs. 1 and 4.*Cucullæa robusta*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 340, t. 20, f. 1.,, *costata*, Etheridge, *Ibid.*, t. 20, f. 2.

*Sp. Char.* Shell trapeziform or rhomboidal and nearly equilateral; body of the valves very convex and inflated; dorsal margin straight, long; area wide and flat; posterior teeth three or four, horizontal crests of the teeth and bottoms of the sockets denticulated; ventral margin rounded, closed, the interior wide and flattened; anterior and posterior ends truncated; umbones large, gibbous, distant, and incurved; pallial line straight; costæ or ribs thirteen to twenty-four in number, equal, sharp, composed of from three to five subordinate ribs, the posterior end apparently devoid of ribs; interspaces wide, filled with very fine riblets parallel to the principal costæ.

*Obs.* It is very questionable if two species exist at Maryborough, where these shells appear to be moderately common. I have therefore combined both for the present under one name.

The ribs, or costæ, become wider apart towards the extremities of the valves, and are sharp with wide interspaces. The latter are filled with very fine riblets, and the whole surface is well cancellated by sub-imbricating frills. The usual number of principal costæ is thirteen, three on the anterior end and the remainder confined to the body of the shell, the posterior end being apparently devoid of them, or at any rate with the costæ very faintly developed. Between each pair are four or five smaller or secondary costæ, besides the five lines previously mentioned.

*Cucullæa virgata*, J. de C. Sby.,\* from the "Upper Secondary" Formation of Cutch, is remarkably like *C. robusta*, both in shape and ornament.

*Loc.* Maryborough (*The late R. Daintree*); Corporation Quarry, Maryborough (*W. H. Rands; Messrs. T. W. E. David and G. Sweet—Collns. David and Sweet*).

## Family—NUCULIDÆ.

Genus—*NUCULA*, Lamarck, 1799.

(Prodrome—Mém. Soc. Hist. Nat. Paris, 1799, p. 87.)

*NUCULA QUADRATA*, Etheridge, Pl. 26, figs. 8 and 9.*Nucula quadrata*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 341, t. 19, f. 5, t. 20, f. 3.

*Sp. Char.* Shell quadrate and tumid, umbones anterior, and anterior side short and vertical; posterior side much elongated and sharply rounded; teeth on posterior side large and numerous; those on anterior side few (seven or eight) and smaller; posterior dorsal margin flat. (*Etheridge*.)

*Obs.* This and the following species appear to be unusually large for Cretaceous forms. The muscular scars and pallial line are very strongly marked in the cast. In one of Mr. Etheridge's original figures of this species the scars of the retractor(?) muscles, usually met with on the visceral region of the interior surface of *Nucula*, are exceedingly developed, and give to the surface of the cast quite a pock-marked appearance. It is a rather thick, heavy species, with fifteen or sixteen posterior, very large hinge-teeth.

\* Trans. Geol. Soc., 2nd Ser., v., Expl. t. 22, t. 22, f. 1.

*Loc.* Maryborough (*The late R. Daintree; the Hon. A. C. Gregory; Messrs. T. W. E. David and G. Sweet*—Collns. David and Sweet). Occurs also in the Rolling Downs Beds.

*NUCULA GIGANTEA*, *Etheridge*, Pl. 26, figs. 6 and 7.

*Nucula gigantea*, *Etheridge*, Quart. Journ. Geol. Soc., 1872, xxviii., p. 341, t. 20, f. 4.

*Sp. Char.* Shell ovately oblong; dorsal margin nearly horizontal; ventral margin nearly semi-circular; umbones placed very anteriorly and nearly straight; hinge-teeth thirteen or fourteen, on posterior side, and five or six on anterior side of umbo. (*Etheridge*.)

*Obs.* The ligamentary pit in this species is large and spoon-shaped, and directed towards the posterior end. One specimen examined possessed sixteen teeth on the posterior hinge, and another from Port Curtis only ten, but this may depend on preservation. The exterior was ornamented with fine concentric lines.

*Loc.* Maryborough (*The late R. Daintree; Messrs. T. W. E. David and G. Sweet*—Collns. David and Sweet); near Mullet Creek, twelve miles south of Rosedale Station, Port Curtis (*W. H. Rands*).

*Genus*—*NUCULANA*, *Link*, 1807.

(*Beschr. Natur. Samml. Rostok*, iii., p. 155.)

*NUCULANA* (? *YOLDIA*) *RANDSI*, *sp. nov.*, Pl. 26, fig. 10.

*Sp. Char.* Shell elongately ovate, rather tumid, moderately large, rostrate posteriorly. Cardinal margin or hinge-line somewhat convex in front, excavated or concave behind, with about fourteen teeth both on the anterior and posterior sides. Anterior end rather produced; anterior and ventral margins rounded. Posterior end bluntly rostrate, curved upwards. Umbones sub-central.

*Obs.* The surface markings and the pallial line are not visible, but I believe the species is referable either to *Nuculana* or *Yoldia*. It is allied to such as *Leda protecta*, Gabb,\* and *Yoldia scaphuloidea*, *Stoliczka*,† more particularly the latter, but differs in size and in having a more acute rostrum.

The species is named in honour of Mr. W. H. Rands, Assistant Government Geologist of Queensland.

*Loc.* Isis River, near Bundaberg Road, Wide Bay (*W. H. Rands*).

*Genus*—*ADRANA*, *H. and A. Adams*, 1858.‡

(*Gen. Recent Moll.*, ii., Pt. 33, p. 547.)

*ADRANA ELONGATA*, *Etheridge*, *sp.*, Pl. 33, fig. 8.

*Leda elongata*, *Etheridge*, Quart. Journ. Geol. Soc., 1872, xxviii., p. 341, t. 20, f. 5.

*Sp. Char.* Shell elongated, length nearly double the height; umbones nearly central, nearer anterior than posterior margin; teeth very numerous on both sides of umbo, anterior twelve or thirteen, posterior fifteen. (*Etheridge*.)

*Obs.* In form this species seems to approach much nearer to *H. and A. Adams'* genus *Adrana* than either to *Leda* or *Yoldia*. The resemblance to *Leda scapha*, d'Orb., does not appear to be so apparent, as stated by Mr. *Etheridge*. As regards *Yoldia scaphuloidea*, *Stol.*, of the Arriallor Group of India, the likeness is greater, but the two shells are clearly distinct. When perfect, the anterior margin is regularly rounded, and

\* *Pal. California*, 1864, i., p. 199, t. 26, f. 185.

† *Pal. Indica* (Cret. Fauna), iii., 1871, Fas. 5-8, p. 324, t. 17, f. 11 and 12.

‡ *Non Adrana*, *Loew*, 1873, a genus of Diptera, nec *Adrania*, *Stål*, 1863, a genus of Hemiptera.

tolerably deep from the dorsal to the ventral. There is no definite evidence of the valves gaping, although some appearance of this does exist at the posterior end of one specimen. It was evidently a very much compressed species. An example collected by Prof. T. W. E. David measures one and a-half inches in length.

*Loc.* Maryborough (*The late R. Daintree; T. W. E. David*—Colln. David, Sydney).

### Family—TRIGONIDÆ.

#### *Genus*—TRIGONIA, Bruguière, 1789.

(Encycl. Méthod. i., Pl. 14.)

#### TRIGONIA NASUTA, Etheridge.

*Trigonia nasuta*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 339, t. 19, f. 2, 2a.

*Sp. Char.* Shell triangular or deltoid, much produced or elongated at the posterior end; anterior side truncated; umbones prominent and thick; hinge area and teeth not preserved, save a few on the posterior area. (*Etheridge.*)

*Obs.* We possess only the cast of this shell, and had it been found in the Cretaceous rocks of Britain we should have allied it to *Trigonia alæformis*, Park., or *T. caudata*, Ag., but from the umbo to the ventral margin it is much higher or deeper than either of the two forms referred to. I am inclined to believe that the concentric folds or ribs supported tubercles upon them, as in *Trigonia scabra* and *T. caudata*. I unhesitatingly refer it to the Cretaceous deposits, and it belongs to a type not known in the Jurassic rocks. *T. sanctæ-crucis*, Pictet and Camp., much resembles this shell; and again, Mr. C. L. Griesbach describes a *Trigonia*, from the Umtafuna River, Natal, which has an elongated posterior end, and, in general shape and deltoid form, is much like our shell. (*Etheridge.*)

The folds distributed over the umbonal region in Mr. Etheridge's figure are shown, on the internal cast of a left valve obtained by Prof. T. W. E. David, to occur generally over the whole valve, except on the posterior slope. They are wide and flat.

*Loc.* Maryborough (*The late R. Daintree; T. W. E. David*—Colln. David, Sydney).

#### TRIGONIA, *sp. ind. (a.)*, Pl. 26, fig. 5.

*Sp. Char.* Cast subovately elongate, subconvex, but not inflated; anterior side rounded from the umbones downwards, and but little produced; posterior side produced into an obtuse, somewhat flattened, nasiform extension, with a straight oblique margin; ventral margin rounded, extended, without apparent undulation or excavation posteriorly; hinge-line concave, sloping towards the posterior end; umbones acute, little incurved, nearly vertical to the longer axis of the shell; area narrow and elongate, bounded by a sub-acute ridge from the umbones, which gradually dies out; escutcheon not preserved; dental sockets oblique, divergent, the anterior tear-shaped and long, the posterior thin; flanks of the cast but little convex, whilst the posterior end immediately below the bounding carina of the area bears a depression or groove.

*Obs.* An exceedingly well-preserved cast, which appears to differ from any of the hitherto described Australian Trigonias, but is probably nearest to *T. mesembria*, Woods. It differs entirely in shape from *T. lineata*, Moore, and is not sufficiently pointed at the posterior end for *T. nasuta*, Etheridge. In many points this cast agrees with *Trigonia conocardiiformis*, Krauss,\* from the Cretaceous rocks of South Africa, but is

\* Nova Acta Acad. Cæs. Leop.—Carol. Nat. Curio., 1830, xxii., Pars. 2., p. 454., t. 49, f. 1.

by no means so massive a shell, and some of the internal characters are different; still, it is undoubtedly closely allied to Krauss' species. It does not in any way agree with the other South African Cretaceous shell, *Trigonia Shepstonei*, Griesbach.\*

I think it quite likely that the present shell may be an elongated variety of *T. mesembria*, Ten. Woods, but as the figure of this species represents an individual with the shell on, and the present fossil is only a cast, it is difficult to compare them. On the difficulty of dealing with *Trigonia* casts, the late Dr. Lycett made the following remarks, which are very applicable to these Australian forms. He said:—"It rarely happens that any of the external ornaments are visible upon them; and even under the most favourable conditions the impressions of these ornaments are only faintly and insufficiently shown, so that by means of these alone the external aspect even of a single species could never be fully ascertained, and even when both the mould and test have been obtained it is not in every instance that the mould can with certainty be discriminated from those of other allied species. The practice of authors, therefore, who have described supposed new species even partially, and have named them from internal moulds alone, is objectionable, as tending to create doubt and hesitation in the minds of students, and encumbering the list of species with things which for all practical purposes are little more than mere names."

*Loc.* Maryborough (*Hon. A. C. Gregory*).

#### Family—CYPRINIDÆ.

*Genus*—CYPRINA, Lamarck, 1818.

(*Hist. Anim. sans. Vertéb.*, v.)

CYPRINA CLARKEI, *Moore*, Pl. 27, fig. 9; ? Pl. 26, figs. 18 and 19.

(For description see under "Rolling Downs," p. 474.)

*Obs.* This shell appears to have attained considerable dimensions in the Australian Cretaceous seas, being much larger than the *Cyprina planata* of the Lower Tertiaries of Britain and France. In form and habit *C. expansa* is closely allied to *C. planata*, possessing also the compressed ventral border, deep lunule, and expanded anterior or pedi-lateral margin. (*Etheridge*.)

*C. expansa* is a very characteristic species of the North Queensland Cretaceous deposits. In the Maryborough Beds it has invariably been met with in casts, but in the nodular limestone of the Walsh River portions of the shell are usually attached to the specimens. In some individuals the anterior side is longer, and the dorsal margin very much more oblique, than represented in Mr. Etheridge's figure. The umbones are much incurved, and the lunule deep. The anterior end rather compressed and flattened towards the margins. The pallial line is strongly marked, but the sinus is not deep. The shell, where preserved, is thick and concentrically corrugated, with fine intervening concentric lines.

*Loc. and Horizon.* Maryborough (*The late R. Daintree*; *T. W. E. David*—*Colln. David*, Sydney; *G. Sweet*—*Colln. Sweet*, Melbourne).

In connection with this genus may be mentioned a shell (Pl. 27, Fig. 1) figured † by Mr. Etheridge without name. The following is his description:—"Shell apparently smooth, semicircular, nearly equilateral, equi-valve; umbones central, slightly acute and anterior; posterior and ventral margins equally rounded and smooth; hinge-line straight, rounded at the angles, giving the shell an almost circular appearance."

\* *Quart. Journ. Geol. Soc.*, 1871, xxvii., t. 3, f. 11.

† *Ibid.*, 1872, xxviii., p. 339, t. 19, f. 4.

"*Obs.* It is to be regretted that we have not a particle of the original shell wherewith to recognise the nature of the markings, or even the ventral margin to aid us in determining whether the inner edge was crenulated or plain; externally the shell appears to have been smooth or delicately concentrically marked. The cast of the hinge-line is such as to prevent our determining any teeth below the junction of the two valves.

"In outward form this shell much resembles *Lucina* (*Codakia*) *percrassa*, Stol., from the Arrialoor Group (India); and the shell is nearly equal in length to that of this species, but not so high. The pallial line appears to be simple; and the muscular impressions resemble those of *Pectunculus*. Some *Axinæa* from the Indian Cretaceous rocks, but for their size, would very closely resemble this shell. We possess one specimen only, and that a cast of one valve.

Three similar casts have come under my own observation (Pl. 27, fig. 1), but I am in no way better prepared to offer any definite suggestion as to their generic affinity than was Mr. Etheridge. Cardinal and lateral teeth were undoubtedly present, so that the supposed resemblance to *Axinæa* (*Pectunculus*) may be at once dismissed. The hinge characters, however, are too ill-preserved to warrant us in a complete generic reference, but, in all probability, these shells belong either to the Cyprinidæ or Lucinidæ. For a true *Cyprina*, the umbones are too central, although slightly on the anterior side; whilst the absence of crenulations along the ventral interior of the valves separates them at once from that section of *Codakia* referred to by Mr. Etheridge.

Prof. K. Martin has described a large shell, having much the appearance of our fossils, but with the shelly matter preserved, from the Tertiary Beds of Java. He provisionally refers it to *Lucina*.\*

Prof. J. D. Dana, again, has figured a similar form, referred to the same genus, from the Tertiary series of Oregon, under the name of *Lucina acutilineata*.† The outline corresponds well with our shell.

The almost central beaks, and nearly round outline, with an apparently indefinite or smooth surface ornament, are features of too marked a character to be easily passed over. The posterior muscular scar was large, deep, and round-oval, and the pallial sinus wide and open, and it is not impossible that we may here have the foreshadowing of a new genus. In two of the specimens one of the valves has been thrust upwards, producing an apparent inequality of the valves, but in the third they are normal.

*Loc.* Maryborough (*The late R. Daintree*).

## Order—LUCINACEA.

### Family—LUCINIDÆ.

*Genus*—*UNICARDIUM*, d'Orbigny, 1850.

(Prod. Pal. Strat., i, p. 218.)

*UNICARDIUM*? *ETHERIDGEI*, *sp. nov.*, Pl. 27, fig. 1.

*Genus*?, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 339, t. 19, f. 4.

*Sp. Char.* Shell large, more or less semicircular, if anything slightly oval, the transverse measurement being slightly the greater, nearly equilateral, convex, and inflated in the umbonal region. Dorsal margin nearly straight, rounded at the lateral angles; anterior and ventral margins rounded, but the posterior slightly produced.

\* Sammlungen Geol. Reichs Mus. in Leiden, 1883, i., No. 5, Heft 4, t. 13, f. 43.

† Geology, Wilkes' U. S. Explor. Exped., 1849, x., Atlas, t. 18, f. 2.

Umbones large, incurved, slightly anterior. Cardinal teeth large, apparently one in each valve; the dorsal margin thickened internally on the posterior side, and assuming a rather lateral, tooth-like appearance. Adductor muscular scars well developed, especially the posterior, which is deeply excavated on the outer side. Surface with wide concentric laminae, and intermediate finer lines of growth.

*Obs.* The reference to *Unicardium* is made provisionally, as the casts of this shell have long puzzled me, as did those in Daintree's Collection perplex Mr. Etheridge. It always occurs as internal casts and from the one locality, the almost equilateral form and central beaks being among its chief peculiarities.

The pallial line is simple, although in our illustration (Pl. 27, fig. 1) it appears sinuated, but this only arises from a fracture, all other specimens having presented a perfectly continuous line.

Named in honour of my Father, Mr. Robert Etheridge, F.R.S.

*Loc. and Horizon.* Corporation Quarry, Maryborough (*The late R. Daintree, and R. L. Jack; G. Sweet*—Colln. Sweet, Melbourne).

## Order—TELLINACEA.

### Family—TELLINIDÆ.

*Genus*—*PALÆOMÆRA*, *Stoliczka*, 1870.

(*Pal. Indica* (Cret. Fauna), 1870, iii., Fasc. 1-4, p. 116.)

*PALÆOMÆRA MARIÆBURIENSIS*, *Etheridge*, sp.

*Tellina Mariæburiensis*, *Etheridge*, Quart. Journ. Geol. Soc., 1872, xxviii., p. 341, t. 20, f. 6 and 6a.

*Sp. Char.* Shell compressed, transversely elongated, nearly equilateral, acutely rounded anteriorly; posterior margin slightly truncated; lines of growth strongly marked and band-like; these concentric bands are broad and of equal width. (*Etheridge*.)

*Obs.* In many respects this shell resembles *Tellina* (*Palæomæra*) *inconspicua*, Forbes, from Trichinopoly; but the band-like markings, if in the external shell, which they appear to be, remove it from that species; in form, size, and habit, however, it closely approaches the latter. (*Etheridge*.)

The distant concentric depressions appear to be a very characteristic feature in this species.

*Loc.* Maryborough (*The late R. Daintree; G. Sweet*—Colln. Sweet, Melbourne).

*PALÆOMÆRA?* *sp. ind.*, Pl. 26, fig. 17.

*Tellina sp.*, *Etheridge*, Quart. Journ. Geol. Soc., 1872, xxviii., p. 341, t. 20, f. 7.

*Obs.* This species is less elongated and more deltoid in form than *P. mariæburiensis*, and apparently possessed a smooth shell instead of the banded structure of that species; the anterior side is obtusely rounded, and the posterior more acute. (*Etheridge*.)

A small form resembling this occurs in the Walsh River nodules, but the specimens appear to have an inflection in the posterior ventral margin.

*Loc.* Maryborough (*The late R. Daintree*).

*Genus*—*GLYCIMERIS* (*Klein*), *Lamarck*, 1799.

*Glycimeris* (*Klein*), *Lamarck*, Mém. Soc. Hist. Nat. Paris, 1799, p. 83 [non *Lamarck*, 1801, Syst. Anim. sans. Verbéb., p. 126 = *Cyrtodaria*, *Daudin*].

*Panopea*, *Ménard de la Groye*, Ann. Mus. Hist. Nat. Paris, 1807, ix., p. 135

*Obs.* *Glycimeris* is here used as originally proposed by Klein, and adopted in his earlier writings by Lamarck, who was a binomial Author. As employed by the

latter in his "Système" it is equal to *Cryptodaria*, Daudin. In this sense *Panopea*, Ménard, simply becomes a synonym. The two species described by Mr. Moore it is almost impossible to recognise, the figures are so indefinite and badly executed. They may be here described under other names, but in such cases this cannot be avoided.

GLYCIMERIS SULCATA, *Etheridge, sp.*, Pl. 17, fig. 18.

*Panopea sulcata*, Etheridge, Quart. Journ. Geol. Soc., 1872, xxviii., p. 342, t. 21, f. 2 and 2a.

*Sp. Char.* Shell oblong, transversely or ovately elongated, thin, with many concentric, deeply sulcated plications or furrows; umbones pointed, anterior side much rounded, posterior side acute. (*Etheridge*.)

*Obs.* This shell resembles *P. orientalis*, Forbes\*; but the concentric sulcations are fewer and coarser, the posterior margin is more acute, and the umbones slightly more central. It also much resembles *P. Prevosti*, D'Orb.,† but our shell is more coarsely plicated than either of the abovenamed species. (*Etheridge*.)

Crushed examples appear to be plentiful in the Maryborough Beds. What appears to be a short variety also exists with few and exceedingly coarse concentric ribs. Individuals of *G. sulcata* vary greatly in appearance, both as regards the coarseness of the furrows on the surface, and the marginal outline of the anterior end. Impressions of the thickened hinge-margin are usually well displayed on these casts. The posterior end gaped but little.

This is certainly distinct from *G. rugosa*, Moore, judging from the form and concentric, corrugated laminæ, but it may be allied to Moore's *Mya Maccoyi*. The later Author says that the anterior margin of his species is truncated and angular, and so is that of *G. sulcata*. If the former is also a somewhat long and narrow shell, resembling a specimen in Prof. Tate's South Australian Collection, the resemblance is intensified. Specimens of this species are always so crushed that it is difficult to say what the precise structure of the dorsal margin was—whether a ligamental fulcrum existed as in *Glycimeris*, or a cartilage process as in *Mya*.

The variety is short and obtuse, and is distinguished by having the length much less in proportion to the width (Pl. 17, fig. 18) than the species proper. It may perhaps represent a distinct species.

*Loc.* Maryborough (*The late R. Daintree*); Corporation Quarry, Maryborough (*W. H. Rands*; and *G. Sweet*—Colln. Sweet, Melbourne).

GLYCIMERIS RUGOSA, *Moore, sp.*, Pl. 28, figs. 4 and 5, ? f. 6.

(For description see under "Rolling Downs Beds," p. 478.)

*Loc.* Prof. T. W. E. David has collected an internal cast in the Corporation Quarry, Maryborough, which appears to be too large a shell for *G. sulcata*, Eth., and may indicate the presence of the present species.

Occurs also in the Rolling Downs Beds.

Genus—*CEROMYA*, *L. Agassiz*, 1842.

(*Etudes crit. Moll. Foss.* 2e., p. 25.)

*CEROMYA* ? *sp. ind.*, Pl. 26, fig. 20.

*Obs.* This ill-preserved, although stratigraphically important, cast is provisionally referred to the present genus. One valve is much crushed, but the other is

\* Trans. Geol. Soc., 2nd. Ser., vii., p. 139, t. 17, f. 4.

† Pal. Franç. Terr. Crét., 1843, iii., p. 334, t. 356, f. 3 and 4.

fairly intact; but the whole of the test has been removed. It possesses the oblong outline of several species of *Ceromya*, and was similarly inflated about the umbones. The dorsal margin is fairly straight; the umbones much inrolled, overhanging a large false lunule. The exterior was concentrically and broadly laminated as in several *Ceromyæ*. The specimen is five and a-half inches long by three and three-quarter inches high. Its relation to the genus will be apparent if such species as *Ceromya excentrica*, Voltz, sp., are compared with it.

*Ceromya* is chiefly an Oolitic genus, but Agassiz has described species from the Neocomian.

Loc. Maryborough (*The Hon. A. C. Gregory*).

### Family—MACTRIDÆ.

Genus—*LUTRARIA*, Lamarck, 1799.

(Prodrome—Mém. Soc. Hist. Nat. Paris, 1799, p. 85.)

*LUTRARIA*, sp. ind.

Obs. A very indifferent cast may perhaps be referable to this genus. On the other hand it is not unlike some forms of *Siliqua* or *Cultellus*. The specimen is two inches long, and broken posteriorly. It is a cast of the exterior.

Loc. Maryborough (*The late R. Daintree*).

### Order—PHOLADACEA.

#### Family—PHOLADIDÆ.

Genus—*TEREDO*, Linnæus, 1758.

(Syst. Nat., Edit. x.)

*TEREDO*, sp. ind., Pl. 43, figs. 11 and 12.

Obs. Portions of tubes resembling those of *Teredo*, especially the Cretaceous *Teredo amphibæna*, occur in the siliceous rock of the Croydon Gold Field. The valves of the shell are unknown. The tube is moderately tortuous and curved, two and a-quarter inches long, and seven-sixteenths of an inch in diameter. The test is thick. (Pl. 43, fig. 11.)

In addition to the species named there is also a resemblance to *T. partita*, Stoliczka,\* and *T. Requienianus*, Math.,† of the French Chloritic Chalk, but our form is rather larger than the latter. It corresponds with species of this description better than it does with the smaller forms of the Oolitic rocks.

A very interesting specimen (Pl. 43, fig. 12) was given to me by the late Rev. J. E. T. Woods, consisting of a number of shelly tubes of *Teredo*, most of them straight and parallel, but one or two curved, and preserved in a drab limestone. The longest is over two inches, with a diameter of three-quarters of an inch, but the average diameter is a quarter of an inch. Many of these tubes are seen in section, and at the larger end of one of them are two disjointed and displaced valves, probably those of the species. The specimens closely resemble *Teredo crassula*, Stol.,‡ and the section of the valves would agree intimately with those of our fossils.

\* Pal. Indica (Cret. Fauna), 1871, iii., t. 1, f. 1.

† D'Orbigny, Pal. Franç. Terr. Crét., iii., p. 303, t. 348, f. 3-6.

‡ Pal. Indica (Cret Fauna), 1871, iii., t. 1, f. 2 a and b.



Teredo-bored wood also occurs in the Rolling Downs Series, Mr. G. Sweet having obtained such from the Walsh River, and at Hughenden, the borings being from ten to fifteen millimetres wide.

*Loc.* True Blue Hill, Croydon (*W. Samwell*).

## Class—GASTEROPODA.

### Order—PULMONATA.

#### Family—SIPHONARIIDÆ.

*Genus*—SIPHONARIA, *G. B. Sowerby*, 1824.

(*Genera of Shells* i., Pl. 143.)

SIPHONARIA SAMWELLI, *sp. nov.*, Pl. 42, fig. 9.

*Sp. Char.* Shell patelloid, depressed conical; anterior margin expanded on the left side; posterior contracted; apex recurved and much depressed. Surface with a large number of radiating costæ, not all equal in size, but about twelve stronger than the others proceeding direct from the apex; the intermediate and smaller costæ proceed from the margin for two-thirds the distance between the latter and the apex, but do not reach the last-named; the whole are crossed by very wavy and sub-imbricating ridges, which become more numerous and delicate as the periphery is approached.

*Obs.* This shell is known under the condition of impressions of the exterior. The unsymmetrical outline suggested to Mr. J. Brazier, who examined the specimens, the genus *Siphonaria* as a more fitting resting-place than *Patella*. The interior has not been observed.

Of *Siphonaria*, Mr. G. B. Sowerby remarked: "Its lateral canal, and the vertex being obliquely turned backwards, may be considered as its principal distinctive characters, separating it not only from *Patella*, but from *Emarginula*, whose canal is anterior and vertex posterior."

The nearest fossil ally I have seen is *Patella caperata*, Tate, from the Uitenhage Series (Jurassic) of South Africa. This is, however, a *Siphonaria* in all probability, as the "periphery is irregular, and slightly sinuated."

The present species is named in compliment to Mr. W. Samwell, late Goldfield Warden, who collected extensively at Croydon.

*Loc.* True Blue Hill, Croydon (*W. Samwell*).

## Order—PECTINIBRANCHIATA.

### Family—NATICIDÆ.

*Genus*—NATICA, *Adanson*, 1757.

(*Hist. Nat. Sénégal*, Coquilles, p. 172.)

NATICA VARIABILIS, *Moore*, Pl. 31, figs. 2 and 3.

(For synonymy and description, see p. 485.)

*Loc.* Maryborough (*The late R. Daintree*). Occurs also in the Rolling Downs Beds.

## Class—CEPHALOPODA.

## Order—DIBBRANCHIATA.

## Family—BELEMNITIDÆ.

Genus—*BELEMNITES* (*G. Agricola*), *D'Orb.*, 1840.

(*Pal. Franç. Terr. Crét.*, 1840, i., p. 37.)

*Obs.* Mr. Rands notes\* the presence of "numerous casts of *Belemnites*" in the Maryborough Desert Sandstone in a quarry "just a couple of hundred yards on the Maryborough side of the Copenhagen Bend" of the Mary River. I have not seen any of these casts, but Prof. T. W. E. David obtained a portion of the highly altered rock at the Corporation Quarry, Maryborough, with an elongated cavity, which may be either that left by the decomposition of a *Belemnite* or a *Dentalium*.

Another specimen in Mr. Sweet's Collection is an elongated hollow, in the proximal end of which reposes a portion of a phragmacone. The distal extremity bears two lateral ridges indicating the lateral grooves, and the distal outline gradually swells out with an oval section resulting in a form much resembling *Belemnites Canhami*, Tate, to which it is probably allied, although the apex of the guard is too pointed to be that species.

E.

## CHAPTER XXXV.

### TERTIARY.

#### • LOWER (MIOCENE?) AND UPPER (PLIOCENE?) VOLCANIC ROCKS AND DRIFTS.

##### RUSSELL RIVER AND MULGRAVE GOLD FIELDS, MOUNT MORGAN GOLD MINE.

The presence of Tertiary rocks in Queensland is rather inferred than proved.

To begin with, it is in the highest degree unlikely that this epoch passed over in Queensland without any deposition of either fresh-water or marine strata, such as exist in all the neighbouring colonies. The absence, so far as we know for certain, of Tertiary marine strata may be due to the fact that the elevation which took place after the deposition of the Upper Cretaceous (Desert Sandstone) rocks placed the whole of Queensland above the reach of the ocean during Tertiary times. But in that case we should expect a wide-spread accumulation of fresh-water deposits.

Daintree, indeed, who describes the Desert Sandstone as "without doubt the most recent, widely-spread stratified deposit developed in Queensland," and correctly observed that it lies unconformably on the Cretaceous Rocks of the "Rolling Downs," classed the Desert Sandstone as "Cainozoic," adding "all that can be asserted is that its horizon is above and unconformable to the Cretaceous Series of the Flinders." As will be seen in the Chapter relating to the Desert Sandstone, that Formation must be regarded as Upper Cretaceous, the idea of its "Cainozoic" age being no longer tenable.

There is reason to believe that the Tertiary epoch was marked by intense volcanic activity, accompanying or following extensive movements of elevation. It may be well at the outset to glance at the history of volcanic activity in the other colonies in Tertiary times before considering whether Queensland affords any evidence of similar activity.

In Victoria, according to Mr. Reginald A. F. Murray, Government Geologist,\* the Eocene of Europe has no Victorian representative. "The Victorian Lower Tertiary beds, which the term Oligocene has been employed to designate, really belong to the uppermost portion of the Lower Tertiary group, and appear to occupy an intermediate position between the Eocene and Miocene." These consist exclusively of marine deposits.

The Middle Tertiary (Miocene) is extensively developed in Victoria. It comprises "deposits due to marine, lacustrine, and fluvial agencies, and also the rocks of igneous origin, classed as Older Volcanic, which appear to be the youngest of the group, and to form the division between beds of Middle Tertiary and Miocene and those of Upper Tertiary or Pliocene age."

"The Older Volcanic rocks are the latest products, and mark distinctly the close of the Middle Tertiary or Miocene era. There do occur, occasionally, thin volcanic layers, interstratified with the Miocene sedimentary beds, showing that vulcanicity was not altogether dormant during the formation of the latter, but the greatest volcanic activity evidently took place at the close of the period. Where undecomposed, the Older Volcanic basalts are usually dark, dense, and solid, of a polygonally jointed and

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\* Geology and Physical Geography of Victoria. Melbourne: by Authority: 1887.

sometimes distinctly columnar structure, and composed chiefly of augite, labradorite, olivine, and specular iron. They are, however, as a rule, either wholly or partly decomposed. In the former condition they consist of red, yellow, purple, brown, and nearly white amygdaloidal clays, containing hard lumps of less decomposed rock showing concentric structure; in the partly decomposed state, the rock exhibits in sections the appearance of a conglomerate of such concentric masses in a clay matrix.

"In every locality throughout the Colony where the Older Volcanic rocks are at the surface, the soil immediately resting on or derived from them is of great fertility and of exceptional value for agriculture. In the Neerim, Brandy Creek, and other districts in Gippsland, the natural vegetation growing on such soil is of a most luxuriant, sub-tropical character, forming a serious impediment to the labours of the selectors, who, during late years, have eagerly taken up every available acre of such land.

"The sources whence the Older Volcanic lava streams issued have not yet been distinctly recognised; no well-marked points of eruption, such as are common in the Newer Volcanic districts, have been observed, and it would appear that the original volcanic cones have been entirely removed by subsequent denudation, so that it would only be in what are now narrow or small pipe-shaped dykes, easily passed over unobserved, and probably far distant from where the Older Volcanic rocks remain in considerable area, that we might look for the vents whence the flows were poured forth. The original extent covered by Older Volcanic rocks was once very much greater than now. The areas we now see occupied by them are, for the most part, disconnected vestiges of what were once long, continuous, and frequently also widespread sheets, which have been cut into and through by subsequent denuding agencies, so that in many places the Older Volcanic rocks, which, at the time they were poured forth as lavas, flowed down and partly filled in the valleys of the period, are now the cappings of ranges, owing to the erosion of still deeper valleys on either side. Enough still remains to enable some conjectures to be formed as to the areas once occupied by the Older Volcanic rocks. The conclusions arrived at will, however, be better understood after the existing Older Volcanic areas have been described, and will, therefore, be included in the general sketch history of the Tertiary period, given in a subsequent chapter.

"Older Volcanic rock occurs in patches, filling hollows in Miocene and other older formations in the neighbourhood of the Moorabool River, near Maude, and in one place as an intercalated band between marine Miocene beds; it also constitutes a considerable area of the Bellarine district, south of Geelong Harbour.

"From between Ballan and Blackwood down to near Bacchus Marsh the Older Volcanic rock occurs in a number of localities, especially on the Pentland Hills, where some of the undecomposed basalt of this age is highly magnetic.

"From near Romsey down to Melbourne there are several exposures of this rock in beds and banks of creeks that have cut their way down to it through newer overlying formations. Near Flemington is an area consisting of Older Volcanic decomposed basalt, which may be seen in natural section on the bank of the Saltwater River, passing under Upper Tertiary ferruginous deposits, capped with basalt of Newer Volcanic age. From Hoddle's Creek, a branch of the Upper Yarra, a series of disconnected patches, in some places underlain by auriferous gravels, are traceable, in the direction of Melbourne, as far as Lilydale. Other patches occur between the Yarra and the Plenty, near the Kangaroo Ground. This formation occurs again at Berwick and Cranbourne, and has been proved by boring operations to exist beneath some two hundred feet of Upper Tertiary deposits near Frankston. Cape Schanck and portion of the country between Western Port and Port Phillip, also Phillip Island and French

Island, in Western Port Bay, consist of Older Volcanic rocks, in places undecomposed, and consisting of hard, dark, dense basalt. This rock, more or less decomposed, occupies a strip extending from Griffith's Point along the east coast of Western Port Bay, and I believe this to be portion of and continuous with the French Island and Phillip Island layers, and to be united, beneath the Newer Tertiaries, with the Older Volcanic rocks which occupy so extensive a tract in the Neerim and Buln Buln district.

"Large and small strips and patches are found between the Tanjil and La Trobe Rivers, and in various portions of South Gippsland. A well-defined lead, covered by two hundred feet of older basalt, has been proved to trend, from between Walhalla and Mount Baw Baw, southward to the level country near Toongabbie. Very extensive sheets of older basalt probably underlie parts of the low Upper Tertiary country of Gippsland, as it may be seen sloping from the hilly country, and passing under the plains at Haunted Hill, Toongabbie, Seaton, Glenmaggie, and also at many places on the south side of the La Trobe Valley. The basalt of the Dargo and Bogong High Plains has been classed as Older Volcanic, because it immediately overlies sedimentary beds containing Miocene flora, and its lithological character also justifies this classification. Here we find many hundreds of feet in thickness of lava, for the most part undecomposed, and often highly magnetic, showing, in many places, columnar structure in a marked degree. Portions of the plains where the rock is bare resemble a pavement of five-sided blocks; while, on the slopes below the escarped edges of the plains, acres in extent are covered with pentagonal columns of basalt like logs confusedly heaped together.

"Similar outliers of basalt, but of less extent, occur at Connor's Plain and Fullarton's, Spring Hill, both points on the Main Divide between the Gippsland and Murray River basins; also to the southward at Mount Useful and Mount Lookout, the ranges between the Aberfeldy and the Thomson, and between the Thomson and the Tyers Rivers. A very small outlier occurs on the east slope of Mount Matlock, and other patches are found on the Southern Spur, between the sources of the Yarra and those of the La Trobe.

"The general evidence obtained from observations of the Older Volcanic areas points irresistibly to the conclusion that they are remnants of extensive lava-flows which poured down the valleys of the Miocene period, partially filling in the basins and covering the sedimentary deposits in them, and also spreading in wide layers over the beds of the estuaries and inlets. Subsequent denudation has cut through and destroyed the continuity of these lava-flows; new channels have been excavated to lower levels than the ancient ones, which they filled, and fresh accumulations have in many places over-spread them."

Under the head of Upper Tertiary, Mr. Murray says,\* "are included all aqueous deposits marine or fluvial, and associated lava-flows, younger than the Older Volcanic and older than the Newest Volcanic rocks, which latter are taken as the latest products of the Tertiary period; deposits newer than they being regarded as Post-Tertiary and Recent."

"The basalts, or anamesite and dolerite lavas, familiarly known as 'bluestone,' occur in sheets or strips of varying breadth overlying a large extent of the central western portion of Victoria. The great plains of the Western district, from Geelong to Hamilton, and from Colac to Ararat, are nearly wholly of volcanic origin, while most of the ancient river-beds or leads trending north and south from the Main Divide are more or less filled in and covered by lava-flows, which, though often confined between elevated Silurian ridges near the hilly country, spread out and unite with the wide sheets

that constitute the plains. To the northward of Ballarat, portion of the Main Divide itself is of volcanic formation, and a wide sheet extending to the north, and finally disappearing under the Post-Tertiary deposits of the Loddon, covers the system of deep leads of Creswick, Clunes, and Daylesford, on their trend towards the Murray. At Ballarat there are four, and in other places two or three, distinct layers of basalt covering the leads.

"The lowest overlies the deepest part of the gutters, and the next in succession spread more widely, till, as may now be seen, the uppermost lava-flow forms a wide sheet, covering not only the old rivers and their tributaries, but also most of the lower ridges of Silurian rock which separate them.

"Throughout all the Newer Volcanic areas are found the points of eruption whence the lava streams issued, mammaloid or conical hills, in many of which well-formed crater-basins still exist, while in others the crateriform shape is still distinguishable, though the basin has been obliterated. Many of these extinct craters are now occupied by lakes or lagoons, as Tower Hill, near Warrnambool, which has an insular peak rising from the centre of the lake; Mount Eels, and other crater basins in the western district, and Mount Mercer, south from Buninyong. Mounts Buninyong, Warrenheip, Pisgah, Franklin, and numerous other volcanic hills in the Ballarat, Creswick, Daylesford, and other districts, are familiar instances of points of eruption where the outlines of the craters are still discernible.

"Around nearly all such points are scoriaceous lavas and volcanic ashes, among which are frequently found ejected masses of older rocks, from mere dust up to several tons in weight.

"For instance, in the volcanic ash of the Anakies, near Geelong, are found ejected blocks of granite. At Buninyong and Hardie's Hill, to the south thereof, are ash beds, composed principally of large and small fragments of slate and schist. In some places, as on the Werribee Plains, near Mount Mary, the ash beds present a stratified appearance, as though their materials had fallen into and had been arranged by water. It is probable that this may have been the case, but there is no evidence of any very considerable submergence since, as, had such taken place, very few, if any, of the volcanic hills, composed as they are of loose incoherent materials, would have preserved their form as we now see them. It is probable, however, as suggested by Mr. Selwyn, that some of them formed low islands in the Tertiary seas."

Of the New South Wales Volcanic Rocks, the late Mr. C. S. Wilkinson wrote \* :—  
 "The volcanic rocks, dolerite, basalt, amygdaloid, &c., are almost entirely of Tertiary age. They occur in many places on the high lands of the Great Dividing Range, forming plateaus, and also upon its eastern and western slopes. They have been chiefly erupted from 'pipes or fissures,' without forming any of those conical hills with crater-basins which so characterise many of the points of eruption in the volcanic districts of Victoria. The lofty Conobolas, near Orange, are, however, extinct volcanoes.

"In the Gulgong Gold Field we have amygdaloidal basalt containing analcime, stilbite, &c. From its position in regard to the drifts, it is probably of Upper Miocene age; while overlying the Pliocene drifts (deep leads) in the same locality occur extensive flows of basalt, which have filled up old valleys, and here and there spread out over considerable areas. Similar occurrences may be observed in the stanniferous districts of Inverell and in several other parts of the colony.

"Basaltic rocks occupy some of the highest points of the Dividing Range near Kiandra, as at Mount Table-top, which is over 5,000 feet above the sea, and which the late Mr. Lamont Young, who explored it in 1880, regarded as a point of eruption.

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\* Notes on the Geology of New South Wales, by C. S. Wilkinson, Government Geologist. Sydney : by Authority : 1882, p. 62.

"Near Inverell the Pliocene basalt contains large crystals of herschelite, with analcime and aragonite, also small rounded masses of olivine. Basalt of the same age caps the Bald Hills, near Bathurst; it here exhibits columnar structure."

Referring to the basalts and associated drifts of New England, Mr. T. W. Edgeworth David says\* :—

"During the greater part of that vast period of time (the Mesozoic) the surface of the land was being slowly broken up and worn down by the action of rain, frost, sunshine, vegetation, and perhaps marine erosion, until a land surface was evolved, which in its broad features resembled the present. Vast thicknesses of sedimentary material having been removed by these means, the underlying crystalline rocks were laid bare, and, erosion proceeding still further, the crystalline rocks themselves and their metalliferous veins became disintegrated and their materials transported and redistributed by water. In this way were formed the deposits of gravel, of which the outliers at Scrubby Gully and Ruby Hill are the insignificant remnants. The intensely worn surfaces of the pebbles in this gravel, and the fact that only the hardest and most indestructible minerals—as quartz, tinstone, and gemstones, &c.—have survived in them, shows that they must have been subjected to a long process of battering and bruising, in which the weaker pebbles of claystone, granite, &c., were completely pulverised. The only power in nature capable of doing such a work is the sea, where it breaks on a rocky coast. These Tertiary gravels are, therefore, probably of marine origin, a fact of great significance as bearing upon the probable richness of stream tin of the 'deep leads,' for marine beds must have had a wide extent, and the great richness of these small outliers favours the expectation that the far larger portions which have been swept away were equally rich; so that large bodies of ore derived from this source must have gravitated into the lower level gravels subsequently buried under lava. As the land continued to rise the sea would recede further west, and the rivers being increased in size and power subaerial degradation would proceed more rapidly. The channels of the rivers would be continually deepened, and the whole surface of the land gradually lowered to adapt itself to the increasing fall of the rivers. The three terraces of gravel at the Surprise Mines mark the levels at which the bottom of a large river stood at three successive epochs. What was the exact configuration of the country at the time of the first outburst of the basalt lavas geological evidence fails to tell. That part only which has been sealed up under the lava sheets has been preserved to the present day, and its shape is being gradually restored by the workings on the 'deep leads.' The results of these subterranean explorations tend to show that most of the country now covered by lava sheets, and forming in places main lines of water parting, was at that time near to or part of the principal drainage channels, and that the trend and fall of these old rivers agreed approximately with that of their nearest modern equivalents. Of course there are no exact modern representatives of these old streams, nor is it always possible to determine, even approximately, with what present rivers they should be correlated. At the Fishing Grounds, however, near Kangaroo Flat, there can be no doubt that the old stream, which produced the coarse shingle now capped by lava, was related to the present Beardy River. The bottom of the channel of the Beardy at the nearest point, one mile distant, is now 550 feet below the level of the bed of this buried river channel. The flora of the period, to judge from the number and variety of leaves entombed in the Eocene pipeclays, was rich and diversified. The fossils are chiefly leaves of herbs, trees, and ferns, some having fruit, and one a blossom delicately

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\* *Geology of the Vegetable Creek Tin-Mining Field*, by T. W. Edgeworth David. *Mem. Geol. Survey N. S. Wales*, 1887, p. 58.

preserved. At Rose Valley, near Emmaville, the vegetable matter has almost entirely disappeared, the cast only remaining in the white pipeclay, which is stained a rusty yellow where it has received the impressions of the fossils. At Witherden's tunnel, in portion 50, parish of Hamilton, the fossils are enclosed in a dark brown fine sandy clay, the original material of the leaf being preserved; and at the head of the Wellington Vale Lead, leaves are similarly preserved in a hardened black silt. A collection of the fossil plants from Rose Valley has been sent to Baron von Ettingshausen, and, as already stated, they are considered by him to contain many types found in the early Tertiary flora of Europe and America; thus establishing the age of the oldest leads near Emmaville as Early Tertiary. Amongst them are several varieties of beech and oak, pines allied to the kauri pine, and Wellingtonian pine, intermixed with banksias, grevilleas, laurels, and eucalyptus. A detailed list and description is given in Baron Ettingshausen's work now published. Impressions of fossil insects have been found on the Red Hill, near Emmaville, the markings being plainly visible in fine brown earthy ironstone; but these belong to the later part of the Tertiary volcanic epoch. At a time, then, when the physical features of the country were somewhat similar to what they are now, and its surface, probably some twenty feet or so higher than at present, was covered with an Eocene flora, volcanic energy revealed itself in the first eruptions of basalt. The hard rocks of the quartz-porphry, felstone, and granite were rent open; and, where the volcanic forces became centralised, small cones were thrown up composed of comminuted fragments of the underlying rock and scoriaceous basalt. The lava emanating from these centres poured into the valleys in streams from one hundred to two hundred feet thick, flowing for a distance of from six to twelve miles. Dispossessed of their old beds, the creeks and rivers had to wear for themselves fresh channels, either down the centre of the lava stream, or along one or both of its margins. It is probable that, in accordance with facts observed in connection with recent lava streams, the sides of these old basalt flows in contact with the cold rim-rocks would cool and consolidate while the centre of the mass was still fluid. The result of this would be that the centre of the stream would flow away from the sides leaving them at a higher level, and so giving rise to a slight central depression. This would favour the erosion of the new channel immediately over the site of the old one, where the lava must necessarily have been thickest and so most fluid, and where consequently the lowest point of the depression should lie theoretically. More frequently, however, the water chose the junction lines of the basalt with the Palæozoic rocks. That the volcanic activity was prolonged for a vast space of time is proved by the extent of denudation which has taken place between the older flows of lava and the newer. The amount of this can be measured at the upper end of the Vegetable Creek Lead at Rose Valley. The section at Griffith's and Fox's shafts shows that a watercourse has cut through one or more flows of basalt altogether to a depth of about sixty feet. Then succeeded another flow of basalt, which buried the second channel to a depth of a hundred feet. These second eruptions appear to have been less violent than the first, the lava welling up, probably from wide rents, and producing the low, gently sloping cones of solid lava, destitute of the volcanic dust and scoria characteristic of the earlier outbursts. Evidence as to which is the latest flow of basalt is rather meagre; but judging from the general freshness of the appearance of the lava at Kangaroo Flat, in Portions 70 and 73, Parish of Arvid, it seems to me that this flow is one of the most recent. Powerful streams must have flowed in places over the surface of the basalt long after its consolidation, as evidenced by the coarse Pliocene gravel in Portions 696 and 751, Parish of Strathbogie, where some of the water-worn blocks are over one foot in diameter. This gravel is, roughly, about one hundred and



fifty feet above the Severn River. At the time such a coarse gravel was formed it is scarcely conceivable that the present Severn Valley existed, and its erosion was, therefore, probably subsequent. Here, however, a question of great difficulty arises. The statement already made, that most of the present river channels have been deepened by from three to six hundred feet since the last lava-flows, is generally correct; but what appears to be a remarkable exception to the general rule occurs at Strathbogie. For about a mile above the head station basalt occurs in position a few feet only above the level of the present river; and, on the left bank of the same river, a shaft sunk through the lava proves that it extends to a considerable depth below the river channel. Also on Swamp Oak Creek, one mile north of the north-east corner of Portion 5, Parish of Astley, the basalt comes down within a few feet of the level of the creek. In the latter instance the position of the basalt may be partly due to landlips; but the first case is incapable of such an explanation, and the interpretation of this phenomenon must be deferred until a geological examination is made of the country south of the Severn River.

"These patches of Pliocene river gravel show that at the close of the Tertiary Volcanic period the outpouring of the lava streams by filling up the valleys had locally raised the level of the drainage channels. Running water, however, ceaselessly fretting the rocks, by degrees wore fresh troughs as deep as the old ones, and eventually considerably deeper. The heavy rainfall of the Pleistocene period must have materially accelerated this work of erosion; but in this rocky district, with its steep falls, little trace is preserved of Pleistocene Deposits, except in the wide plains of coarse gravel in the valley of the Dumaresq. The shallow deposits of subangular gravel and sand in the beds of the present creeks and rivers were evidently formed under conditions similar to those which now obtain; and their stratigraphical position, as well as the occurrence in them of natives' stone hatchets, proves them to belong to the recent period."

From Dalton, near Gunning, there have been obtained the remains of a copious Tertiary land fauna, which Baron von Ettingshausen regards as of Eocene date.\* Of this deposit, so far as we know, we have no representative in Queensland.

In South Australia, as will be seen in the Chapter on the Desert Sandstone, that Formation is sometimes not separable from the Lower Tertiary. It appears as if the emergence of the land which took place in Queensland at or near the close of Mesozoic time did not take place in South Australia till somewhat later.

We certainly have in Queensland an Older and a Newer Volcanic series, both chiefly basaltic, which may be presumed to be of Tertiary age, although direct evidence of their age is not forthcoming. The absence of evidence on this point may be due to some extent to the fact that the drift deposits beneath the basalts of Queensland have not been explored for gold as they have been in Victoria.

Our Older Volcanic Series forms extensive beds, which cover the Desert Sandstone, where the latter is present, or the still older rocks where it is absent. The Newer Series occurs as lava-flows or *coulées*, which have flowed down the valleys denuded out of the Desert Sandstone or out of the lower basalts.

#### OLDER VOLCANIC SERIES.

The granitic range dividing the Burdekin and Flinders waters is crossed by the road from Townsville to Hughenden at an elevation of 3,040 feet above the sea-level. The range is flanked on the eastern side by deposits of basaltic lavas extending to

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\* Contributions to the Tertiary Flora of Australia, by Dr. Constantin, Baron von Ettingshausen. *Mem. Geol. Survey N. S. Wales, Pal. i.*, 1888, p. 9.

Dalrymple, on the Burdekin (*see* Diagram-Section Pl. 45, fig. 1). On the western side similar basaltic lavas extend to Tatoo Camp, seven miles above Wongalee Station. Here, at an elevation of 1,840 feet, the lowest bed of the basalt is seen resting on the Desert Sandstone. Outliers of the basalt occur between Porcupine Creek and the Flinders as far as Mount Beckford. In all probability it extended over a considerable portion of the Western interior, from which both it and the Desert Sandstone have now been denuded.

North of Coalbrook Station, on the Northern Railway, fragments of basaltic lava-flows are seen resting on the Desert Sandstone, on the divide between the heads of the Thomson and Flinders Rivers.

Mr. Rands describes \* a basalt about fifty feet in thickness overlying Desert Sandstone in a cañon of the Walker River (Head of the Flinders), which has been cut through loth rocks to the depth of two hundred feet. And in the same river, two and a-half or three miles above the junction of the White Mountain Creek, he says,† “The Desert Sandstone is seen faulted against the schists by a fault running east south-east and dipping south-south-west. The schists and Desert Sandstone are both covered with basalt. The Desert Sandstone is bent up near the fault, and is dipping south-south-west.” Here we have an instance showing that a sufficient period elapsed after the deposition of the Desert Sandstone to permit of its upheaval, probably accompanied by faulting and partial denudation, before the basalt was poured over it.

In the same Report, Mr. Rands describes “a vast table-land of basalt extending for many miles” to the west of the Walker River. “Remnants of this basaltic table-land occur on the east side of the river, between it and Oxley Creek, forming ‘outliers’ which have been separated by watercourses. The remainder of this basalt has been entirely removed by denudation. The cavities in the basalt are full of zeolites. Thin sections of the basalt under the microscope show it to be made up of a ground mass of small interlaced crystals of felspar, with crystals of olivine throughout it. The olivine crystals are much decomposed, especially around the margins of and along the cracks in the crystals. It contains very little magnetite. The basalt is clearly of Tertiary age, overlying, as it does, the Desert Sandstone.”

Mr. Rands, speaking of the Cape Gold Field, says:—“The only instance of basalt on the Cape side of the range is that of Mount Black, situated about nine miles west of the Upper Cape. Mount Black is a hill of schist, capped with basalt about two hundred feet in thickness. The latter is a dense olivine-basalt, and has in places assumed a columnar structure. It possesses magnetic polarity.”‡

An immense area of horizontal basalt occupies the whole district extending from Lake Cargoon and Wandovale on the west to the Burdekin on the east, and from Lolworth Creek on the south to the heads of Emu and Maryvale Creeks on the north. Beds of white pipe-clay are occasionally met with between the beds of basalt. This area is watered by Lolworth, Fletcher's, Allingham's, Emu, and Maryvale Creeks, and the Basalt River. In Maryvale Creek the “Diprotodon-breccia” described by Daintree occurs, so that we here have the age of the basalts defined so far as that they lie between the Upper Cretaceous and the Post-Tertiary. The basalts of this area are known to overlies, at least in their northern portion, gold-bearing drifts, which, however, have never been prospected to any extent.

Further north, between the heads of the Broken River (a tributary of the Clarke) and those of the Einasleigh, horizontal beds of basalt cover a wide stretch of

\* Report on the Cape Gold Field. Brisbane: by Authority: 1891, p. 11.

† *Loc. cit.*

‡ Ann. Progress Report Geol. Survey of Queensland for 1890. Brisbane: by Authority: 1891.

country, resting apparently on the eastern side on the "Star Beds," and on the western on mica schists and granites. This area is thus described by Mr. Maitland in his Report on the "Geology and Mineral Resources of the Upper Burdekin"\*:—

"The basaltic lavas occupy an area of about two thousand square miles at the head of the Burdekin.

"The largest development occurs in the corner near the divides between the waters of the Burdekin and the Einasleigh, and between the Herbert and the Burdekin; they form an extensive plateau, having an average altitude of about two thousand feet above sea-level. The western boundary of this immense plateau has not yet been mapped.

"Basaltic outflows are known to exist at Surprise Creek, a tributary of the Einasleigh. These, which emanated from *foci*, on the Burdekin-Einasleigh Plateau, are crossed by the coach road from Herberton to Georgetown, near Quartz Hill. This is distant about forty miles from the watershed of the Burdekin and the Einasleigh.

"The northern boundary has also not been delineated. Streams of lava have flowed down some of the existing valleys in the neighbourhood of Gunnawarra Station, and have been described in a previous report.† Doubtless the hot springs therein described is but the 'dying gasp' of that volcanic action which was at one time rife in this district.

"In addition to this immense plateau, there occur other isolated patches in the district, shown on the map. These lavas, since their formation, do not appear to have been very much affected by denudation.

"The basalt, of which the tableland is made up, occurs in a series of super-imposed lava-flows, emanating from numerous volcanic *foci*, which rise as conspicuous hills all over the plateau.

"The surface of these lavas is, in places, formed of 'chaotic heaps of angular blocks of basalt, tossed in every variety of disorder,' rendering locomotion a matter of some considerable difficulty, especially with horses. Generally, the surface produces a luxuriant growth of vegetation, well suited for and much relished by stock. The more rugged surfaces of some of the more recent flows are covered with bottle-tree scrub.

"On the other side of the Burdekin, west from the Valley of Lagoons Station, the surface of the lava-flows is full of dismal-looking deep pits, of all dimensions, in which water often accumulates. The formation of these pits appears to be due to the caving in of the surface of a lava stream. The surface of a lava stream flowing from one of the volcanic *foci* cools and hardens, whilst the molten matter flows from beneath, leaving a tubular cavern; in course of time, a portion of the hardened surface gives way, and a pit with vertical sides is the result. These caverns can sometimes be followed for a considerable distance; they form excellent hiding-places for the natives. Water can often be seen and heard flowing at the bottom of these holes. Many of these large holes, filled with water, are met with on the divide between the Herbert and the Burdekin. In the whole of the area examined there was found no trace of any fragmental rocks associated with the basaltic outflows. It is conceivable that denudation may have removed all trace of the more incoherent material ejected; but still it is hardly likely that in an area of two thousand square miles there would not be some fragments left

"Professor J. D. Dana,‡ in the course of his studies in vulcanology, has concluded that basaltic lavas are but rarely associated with fragmental deposits (ashes, cinders, and

\* Brisbane: by Authority: 1891.

† "The Geology of the Coolgarra Tin Mines and Surrounding Districts." A. Gibb Maitland. Brisbane: by Authority: 1891.

‡ J. D. Dana, Characteristics of Volcanoes. London: 1890.

the like). When such discharges do take place, they are usually occasioned by the diminution of the internal heat. Hence it would appear that ashy deposits from basaltic volcanoes are among the last stages in their history.

"In the Cooktown and the Herberton districts there do occur beds of ashes which emanate from basaltic cones; but whether these are of later date than the Burdekin-Einasleigh lavas, yet awaits proof.

"Throughout the area occupied by the lavas, there is a very great difference both in texture and colour. Some portions are very vesicular and slaggy, whilst others have that peculiar 'ropy' or wrinkled appearance, characteristic of lava streams, which have flowed slowly from their source; others, again, are fairly compact. In colour they vary from bluish-grey to bright red, with all degrees of variation. In cavities in the basalts beautiful specimens of chalcedony can sometimes be seen.

"The black soil formed by the decay of the rocks is often crowded with fragments of semi-opal.

"A number of slices of the basalts have been prepared and submitted to microscopic examination.

"A partial analysis of a specimen from the Valley of Lagoons has been made for me by Messrs. Coane and Clarke, Charters Towers, with the following result:—

Combined silica ... ..	43.8 per cent.
Free silica... ..	6.7 "
Iron ... ..	13.5 "

"One example—viz., that from Mount Razorback—would be more correctly described as a magma-basalt, from the fact that the minerals are scattered through a glassy matrix or magma, which by ordinary transmitted light is of a brownish colour. This, however, is merely a local occurrence; a few yards distant from the summit of Mount Razorback the basalt resumes its ordinary type.

"The felspars, which make up the larger portion, occur as long lath-shaped crystals, showing plagioclastic twinning. They are remarkably clear and fresh, and contain numerous minute inclusions.

"Olivine, in crystals and crystalline grains, is altered along its edges into a ferruginous product. Sometimes the whole of the crystals and grains have undergone this alteration, but generally the decomposition is found to extend only a short distance from the periphery.

"The augite occurs in long brownish crystals, often showing faint dictorioism, and magnetite in grains.

"In the slices of any of the basalts which were examined, there occurred a little clear transparent isotropic matter.

"Some portions of the glassy matter contain minute particles of some doubly refracting mineral (quartz?).

"The partial analysis made by Messrs. Coane and Clarke shows the presence of a small quantity of free silica, and to this the isotropic matter may be referred.

"There existed no primary quartz in any of the slices of these basalts.

"All over the plateau numerous small 'puys,' the remains of orifices from which these basaltic lavas emanate, are met with.

"Ascending the Valley of Reedy Brook to its head, and crossing the divide into the waters of Gunnawarra Creek, a tributary of the Herbert River, a good idea of the mode of occurrence of the lavas and the structure of the volcanic *foci* can be obtained.

"Much more work will be necessary before a full description of the whole of the sources of the lava on the plateau can be obtained.

"Mount Lang is situated on the eastern bank of one of the heads of Kinrara Creek; its summit is about four hundred and forty feet above its base. The hill presents a steep face to the west, with a somewhat gradual slope to the east, and is formed of very vesicular basalt, which sometimes has a reddish hue. Its western face has a vertical wall of bare basalt, through which fragments of scoria are scattered. Round about the base the fragments of basalt have a tendency to weather into rudely hexagonal blocks.

"Leaving Mount Lang and travelling almost due north, with the object of reaching Mount Razorback, several minor 'puys' are passed. These were only visible when in close proximity, owing to the dense timber.

"About three miles from Mount Razorback, and to the south-west of it, a conspicuous hill formed of vesicular basalt was examined. This hill is in shape semi-circular, with its diameter running north-west and south-east. It is a breached lava cone, the stream flowing north-east from it and thence down one of the heads of Anthill Creek.

"Mount Razorback is situated in the northern portion of the area, and is by far the largest and most conspicuous of any of those occurring within the Burdekin watershed.

"Its shape is that of a long razor-backed ridge, with a conspicuous eminence forming its highest summit, which, by aneroid, is 680 feet above its base. The mountain is composed of basalt of a reddish colour near its highest point, but of a bluish-gray throughout.

"The basalt is very vesicular and somewhat glassy in places. From the summit, as many as twenty-five minor 'puys' are visible; these appear to be much more plentiful to the west. They assume all shapes and sizes; sometimes merely a slight elevation marks their position, as though the molten matter had merely oozed out from an orifice and flowed away on all sides.

"In other parts of the district outlying patches of basaltic lavas are met with.

"A well-marked area is to be seen in the vicinity of Mount Fox, near the head of one of the tributaries of the Douglas River.

"Mount Fox, an extinct volcano, is the culminating point of this area. Its altitude is 2,870 feet above sea-level. In shape it is a truncated cone. The summit comprises an area of two or three acres, surrounded by a low semicircular wall, about thirteen to fourteen feet in height, on the north, with a shallow hollow or depression in the centre. To the south this wall has been breached by a lava which flowed down that side of the mountain, filling up all the inequalities of the surface, and forming a plain of no inconsiderable extent.

"The mountain is almost devoid of timber, save a few patches of scrub on four sides. The portions devoid of timber are covered with sheets of vesicular lava, now broken up into blocks of all shapes and sizes. These timberless portions, now overgrown with long grass reaching to a height of about 2 feet, mark the site of old lava flows.

"From the western side of the peak a conspicuous flow follows the eastern bank of a gully flowing south-west at a considerable elevation above the creek. The flow ends abruptly to the south-west; its surface is covered with blocks of compact basalt.

"All round the mountain denuded tables of basalt can be seen. A conspicuous one consists of a semicircular ridge of compact lava, about 30 yards in width, trending generally north-west for about a quarter of a mile. The summit of this is about 2,310 feet above the level of the sea.

"Nearly due west from this a section, at an altitude of 2,220 feet above sea-level, shows the basaltic lavas resting on a bed of quartzose grit.

"The hill, 2,475 feet high, to the south-west of the section, is formed of a series of successive sheets of lava.

"It is impossible to estimate the thickness of the basalt on the plateau, because there are no data available which will enable an idea to be formed as to what was the form of the ground before the lavas were poured out; and, further, there is no record of their ever having been penetrated by any excavation.

"The age of these basaltic outflows has not yet been definitely fixed. The lavas rest in turn upon all the other rocks in the district; one section, seen near the Valley of Lagoons Station, shows them resting directly upon the Desert Sandstone Beds. The basalts, therefore, are younger than the Upper Cretaceous.

"Mr. Daintree conjectured (presumably on account of their lithological similarity) that the lavas to the north of latitude  $21^{\circ}$  were probably the equivalents of the "Upper Volcanic series" of Victoria which were referred to Pliocene-Tertiary.\*

"Lithological similarity is not to be safely relied upon in determining geological age; still there is strong presumptive evidence that all these basalts have been emitted at approximately the same time.

"These Upper Burdekin lavas are in all probability Tertiary, but as to the exact horizon to which they are to be assigned no evidence has yet been collected."

It is impossible, on reading the above account, to avoid suspecting that in the above notes Mr. Maitland is describing basaltic outflows of different ages—an older, to which the bulk of the basaltic tableland belongs, and a newer, to which may be referred the "pays" or foci still remaining in a remarkable state of preservation, and in all probability the flows of basalt which come down the valleys below the edge of the basaltic tableland. One of these comes down the Valley of Reedy Brook, washed on either side by its tributaries Kinrara and Reedy Creeks. This flow is at least twenty-five miles in length, and I was informed by the late Mr. Scott, of the Valley of Lagoons, that it emanated from a crateriform hill near the head of Kinrara Creek.

Beds of white pipeclay are occasionally met with between the beds of basalt on the tableland.

On both sides of the range which divides the upper portion of the Herbert River on the west from the Johnstone and Barron Rivers on the east, are large plateaux of horizontally-bedded basaltic rocks. On the western side the thermal spring of Innot's Creek remains to attest that the volcanic activity has not yet entirely died out. Mr. Maitland has furnished the following Notes on a specimen of the basalt from this district, after a microscopical examination:—

"Specimens collected from the bed of Prior Creek—one of the heads of Mazzlin Creek, a tributary of the Barron, at the crossing of the Port Douglas and Herberton road, where beds of coarse vesicular basalt alternate with others of much finer grain—were found to be of bluish-gray colour, with small grains of olivine set in a fine-grained matrix. Examined under the microscope the rock is found to consist of a fine-grained matrix, made up of lath-shaped plagioclase feldspar, augite, and magnetite, through which large crystalline grains of olivine are scattered.

"The feldspars, which form by far the largest portion of the rock, are remarkably clear and fresh. Under a high power they are seen to contain glass-inclusions, minute needles of apatite (?) and colourless microliths of augite.

"The ferro-magnesian constituent, augite, never occurs porphyritically, but always as a constituent of the ground-mass. Well-defined crystals are absent, the

\* Quart. Journ. Geol. Soc., xxviii., p. 313.

usual form being irregularly shaped granules and granular aggregates, devoid of cleavage. One of the minute colourless augites, presenting the usual eight-sided outline, shows what are undoubtedly lines of accretion.

"The crystals of olivine present all the characters common to olivines of basaltic rocks.

"Irregularly shaped grains of magnetite are of common occurrence.

"A little clear, glassy matrix can be detected."

On the eastern side of the range, the basalts, in horizontal beds, form a tableland at an elevation of between 2,000 and 3,000 feet, extending from the brow of the Coast Range to the base of the Herberton mountains. The tableland is covered with a most magnificent tropical jungle, through which hardly a ray of sunshine can penetrate. The basaltic soil and a heavy rainfall have combined to produce in this region an almost incalculable wealth of cedar and other valuable timber.

Accompanied by Mr. Maitland, I visited, in 1889, the "crater-lake," Lake Eacham. The lake occupies the very summit of the divide between the heads of Petersen's Creek (Barron Waters) and the heads of creeks flowing into the Mulgrave. It is located, but not named, on the Two-mile Map issued by the Department of Lands; but is minutely charted in the "Plan of the Village of Eacham, Parish of East Barron," issued by the same Department in 1889. I observe that Mr. A. Meston\* spells the name Yeetcham, as more in accordance with the native pronunciation. Mr. Meston briefly describes another lake, named "Boonoobagolomee," seven or eight miles to the west, and adds:—"The blacks speak of a third lake much smaller than the others, but so far [October, 1889] it has not been seen by white men."

My companion and I reached Lake Eacham by a track from Halfpapp's Hotel, in "Petersen's Pocket," on the Cairns and Herberton pack-road. At the junction of the roads from the Mulgrave and Russell Gold Fields to Cairns, we found a tree marked "Lake 400 yds., S.W., J. McL., R. Hood." From this point we made a considerable ascent to the highest point of the ridge surrounding the lake, where we found a tree marked 84 over V., which we understood to be the south-east corner of an "Agricultural Area," and another marked with the name of the discoverer and the date of discovery, "J. McLellan, June, '79." This point, from which the first glimpse of the lake was obtained, was 2,680 feet above sea-level by Aneroid measurement. The descent to the lake was very steep, and, like all the rest of the day's journey, clothed with dense jungle. The Aneroid gave the surface of the water as 2,390 feet.

The lake is surrounded by a ridge composed of loose weathered volcanic ash, containing stones up to six inches in diameter, mostly of bombs of a doleritic rock full of olivine. In ascending the lip of the lake we came on rocks *in situ* which we had missed in the descent. These were of rudely stratified "ash" of angular fragments, dipping at 5° away from the lake. The lake has neither affluent nor effluent; and as it stands higher than the surrounding country, and is enclosed by a wall of ashy materials heaped up above the level of the basaltic tableland, I think it is very probable that it really occupies a crater. It is clearly impossible that, in the latitude where it occurs, the lake could have been hollowed out by an ice-sheet, which would, moreover, have levelled the surrounding rim of soft ash. The lip of the crater is not of uniform height; and although it is likely enough that it has suffered greater denudation in some places than in others, it may be conjectured that the greater height of the rim on the western side may be due to some extent to the tendency of the prevailing south-east winds to drive the ejected materials to the leeward. The lake is said to be of vast depth,

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\* Report on the Government Scientific Expedition to the Bellenden-Ker Range. Brisbane: by Authority: 1889.

and to contain no fish. At any rate, we saw none. Neither did we see any water-fowl, which are said also never to visit the lake. There was nothing in the taste of the water to account for this absence of life, if it be a fact. The highest flood-marks we saw were about three feet above the water. It must be remembered that we visited the lake at the latter end of an unusually protracted drought. The slight variation of level might be accounted for by the fall of rain on the lake and its banks on the one hand, balanced by evaporation and leakage on the other.

The "Volcanic Hill"\* marked on the map in "Pinnacle Pocket," on the right bank of the Barron, between the mouths of Leslic and Petersen's Creeks, stands about 200 feet above the level of the basaltic tableland, and is composed of a highly scoriaceous basalt very rich in olivine. There are said to be several similar hills in the jungle in the neighbourhood, and in all probability they are "necks" or "plugs"—i.e., volcanic orifices filled up with solidified basaltic lava.

It is interesting to find two volcanic craters almost side by side, the one filled up with hard lava-form rock, and the other surrounded by friable ejected ash and forming a crater-lake. It is just possible that in spite of their proximity they may be of different ages, the "plug" belonging to the "Older" and the "crater-lake" to the "Newer" Volcanic series. Or they may even both belong to the latter.

On the Russell River, south of Mount Bartle Frere, gold is obtained in considerable quantities, mixed with stream tin ore and (rare) platinum, from gravelly drifts which rest on slates and schists, and are overlaid by horizontal beds of basalt. The basalt is one of many denuded fragments which once formed a part of the immense plateau extending southward from the Mulgrave to the heads of the North Johnstone and westward to near Herberton. In Messrs. Clarke and Joss's Claim, which is the south-eastmost working, the edge of the basalt is seen to overlie a siliceous sandy silt permeated with iron peroxide. The silt shows alternate layers of coarser and finer material, and is in places cross-bedded. It rests on a "washdirt" mainly composed of well-rounded quartz boulders. There are no basalt stones in the wash, and no boulders of granite. The latter circumstance is hard to account for in a valley where granite is frequently to be met with *in situ*. The washdirt varies in this claim from 2 inches to 30 inches in thickness. Between the washdirt and the slaty bed-rock a very fine white siliceous silt, a few inches in thickness, generally intervenes. The fact that this silt is traversed by a few thin veins of quartz renders it probable that the sand was formerly cemented into a sandstone, but has lost its cement after the formation of the quartz veins.

The outcrop of the washdirt has been opened out along the south-eastern and north-eastern side, and a tunnel has been driven through the washdirt for 135 feet from S. 10° E. to N. 10° W. This tunnel is connected with another running 50 feet to the east. Another tunnel has been driven 70 feet to W. 10° S. from a point on the hillside 120 feet N.W. of the northern end of the long tunnel. At the inner end of the 70-foot tunnel the slate bottom rises up and the basalt comes into direct contact with it. This tunnel is only used as a reservoir, from which the water is conducted to the tip at the end of a tramway leading from the mouth of the long tunnel. The basalt is in some places at least forty feet thick, but is often decomposed throughout its entire thickness. It rests, as seen in some places (of which there is an example in an opening near the south corner of the claim), directly on the washdirt, the absence of the upper silt proving that it was poured out over an uneven and denuded bottom.

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\* "Volcanic" is scarcely distinctive enough in the midst of a volcanic region, but the "hill" in the midst of the basaltic plateau is a conspicuous feature.



The washdirt from the long tunnel gives prospects equal to about half-an-ounce to the load, the gold being in very fine grains. Minute flakes of platinum are occasionally found among the gold.

In Burns and Party's workings (half-a-mile to the north-west of Clarke and Joss's), a red decomposing basalt rests on yellow sand which overlies ten or twelve feet of gravel in coarser and finer layers. The gravelly washdirt is irregularly cemented by brown hæmatite. It has gold throughout, which, however, can only be saved from the unconsolidated portions. The bottom is of slate with numerous quartz veins.

In Butler and McDonald's Claim, a quarter of mile north of Burns and Party's, a drive has been made under the basalt. On a bottom of decomposed slate and grit is a cemented gravel about one foot in thickness. On this lies a gravelly wash, having a thickness of two feet and under. The washdirt occasionally has fifteen feet of soft white sand above, and occasionally a few inches of fine siliceous silt beneath, as in Messrs. Clarke and Joss's claim. A shaft above the workings passed through ten feet of basalt, fifteen feet of sand, and five to six feet of gravelly wash. I saw some good prospects washed from the dirt. Slates and greywackes are seen in the gully, striking to W.N.W.

In Robinson and Anderson's Claim, a quarter of a mile further north, a drive shows a very bouldery gravel from two and a-half feet in thickness and under, lying between the slate bottom and a fine white sand. The bottom is very uneven. In one place there is no sand or gravel between the basalt and slate. An open cutting south of the drive showed a fine white sand lying on from eighteen inches to two feet of fine gravelly wash with lumps of ferruginous cement at its base. The bottom was slate. The upper part of the gravel gave 2 dwts. gold per load, and the lower part none. It may be mentioned that Robinson was nearly killed (on 4th January, 1888) by a native who attacked him with a tomahawk while he was engaged in laying down a rail.

Sampson's Claim is on an isolated hill about a hundred feet below the level of the others, and about half-a-mile east of Robinson and Anderson's. A shaft has been sunk through sixty feet of basalt and four feet of gravelly washdirt, and a tunnel had been driven from N.N.W. for 150 feet towards this shaft from the outcrop of the wash. The slate bottom is seen at the mouth of the tunnel. About fifty feet in there are two and a-half feet of gravelly washdirt capped by basalt and resting on a slate bottom. At this point the tunnel had caved in. A little sand was seen on the gravel a few feet short of the cave-in. I saw some very good prospects washed from the dirt taken from the shaft.

The gold in the wash of the Terraces is always so fine that it is difficult to prevent some of it floating out of the prospecting dish. A few ounces of fine-grained stream tin always remain in the bottom of the dish, and the separation of this from the gold is a very tedious process—indeed, with the most careful manipulation a proportion of the gold is always left in the residue of tin ore.

Even at the edges of the drift from which the basalt has been denuded, washing by hydraulic pressure is impracticable, as the trees of the jungle would fall and obstruct the faces. But a convenient and unfailing supply of running water is always at hand for sluicing the gravel, which can be shot down to the sluice-boxes.

The average yield from washdirt reported in Victoria for 1883 was 1 dwt. 20·32 grs.; for 1884, 3 dwts.; and for 1885, 1 dwt. 10·59 grs., per ton. I am certain that the terraces of the Russell River will give a much higher yield than this. The limited workings now opened up are likely to prove only the beginning of an industry which for many years to come will employ the energies of thousands of workmen. The basalt left on the top of the ridge between Cooppooroo and Wairambar Creeks is a narrow tongue, on both sides of which the auriferous drifts which it has preserved from denudation are

easily accessible. But an immense area of the basalt stretches from the Mulgrave to the heads of the Johnstone and westwards to near Herberton, and under this the auriferous drifts probably remain intact.

It seems probable that the Valleys of the Mulgrave, Russell, and Johnstone were dammed up by a volcanic outbreak, so as to form a vast lake, in which for a time a fine siliceous sand was quietly deposited; that the barrier was at length broken down by the stream at the outlet of the lake, and numerous torrents removed the greater part of the sand and brought down gravel charged with gold; that a second barrier was thrown up and a great thickness of fine silt again deposited; and that over the nearly level surface thus produced immense flows of basalt were finally poured out, filling up the lake. The waters draining this area, if the lake had not been filled up, would have found their way to the sea by a single outlet, instead of forming as they do three independent rivers. The immense amount of denudation since the outpouring of the basalt is evident when we consider the number and depth of the valleys, which have been carved out, in places, to a depth of more than a thousand feet, through basalts, older river and lake beds, and slate and granite rocks; but the lesson will be impressed more deeply than any description could do on anyone who can stand on a neighbouring eminence and try to reconstruct, in his mind's eye, the shores which contained the lake.\*

Gold has for some time been worked, chiefly by Chinese, in the Recent alluvia of the Russell and Johnstone. This gold, which is mixed with stream tin, in all probability came, for the most part, from the "leads" under the now denuded basalt. Probably only a small portion of the alluvial gold came directly from the reefs exposed in the slate and granite country since the denudation of the basalt, as a comparatively small area of this country is yet exposed, and not many reefs are known in it.

I am informed by Mr. John Falconer that on the dividing range between the Dawson and Condamine, lava-form beds of basalt overlies the Desert Sandstone in places.

I have also been informed that a cake of basalt overlies the fragment of the Desert Sandstone left on the crown of the ridge dividing the head waters of the Langlo River from those of the Coorni Paroo, between Tambo and Adavale.

It may be thought remarkable that numerous sheets of lava should have been poured out, one after another, and retain such an even surface. No doubt the fact that this has been the case argues a high degree of fluidity in the lava. Some remarks by Captain Clarence E. Dutton, of the United States Army,† on the Volcanic Rocks of the Zuñi Plateau, New Mexico, may be quoted on this point:—

"It is plain that the lava sheet which forms the capping of the mesa was gradually accumulated by the repeated outpourings of numberless local vents thickly scattered over its broad surface. And yet it may seem a little strange at first that this diffuse form of volcanic action should have produced a surface which is so little diversified. Judging by the analogy of other regions we should have expected to find the thickness of the lava-cap extremely irregular and studded with large cones with intervening valleys of considerable depth. In reality the thickness, as we recede from the base of Mount Taylor, diminishes very slowly, and even at the extreme northern end is quite three hundred feet. In truth Mount Taylor does not appear to have contributed much, if any, to the lava which is more than five or six miles from the immediate base of its cone. The surface of the mesa away from the mountain is but little diversified, and the local cones are for the most part insignificant features. All

\* Report by R.L.J. on the Geology of the Russell River. Brisbane: by Authority: 1888.

† "Mount Taylor and the Zuñi Plateau" in *Sixth Ann. Report U. S. Geol. Survey*, 1884-85.

this indicates a rather mild type of volcanic energy, in which the eruptions were not highly explosive but only moderately so. The more violent eruptions are attended with the ejection of great quantities of fragmental products, while the milder ones disgorge little else than flowing lava. It is well known that the greater the amount of fragmental ejecta, the steeper and more compact is the cone or mountain built up around the vent, while the fluent lava spreads out over wide areas, often flowing great distances, and the slopes which it generates are much gentler and sometimes imperceptible to the unaided eye. As already remarked, fragmental ejecta are common here, and I have seen none at all away from Mount Taylor except the lapilli in the cinder cones. We shall appreciate this mode of growth of a great lava-cap when we come to study the modern lavas in the San José Valley, where their freshness enables us to see every detail of the process.

"We may infer, then, that the state of affairs in the region now occupied by the valley of the Puerco was, during the activity of the vents now represented by the necks, much the same as that which is indicated in the mesa above. From 1,000 to 1,500 feet (according to locality) of Cretaceous strata, since eroded, then overspread the valley and regions to the eastward and southward, also to the northward, from which they have been swept away. Over their surfaces the lavas were outpoured from many vents. The eruptions were of a 'mild' type, attended with little violence, and the ejecta were doubtless lava with few fragmental products. These streams, issuing from many vents, became interwoven with one another, and through a long period of time accumulated, sheet upon sheet, to great thickness, just as they have done in the valley of the San José in modern times. The result was a lava-cap differing in no respect from that which is now seen upon the surviving mesas."

#### NEWER VOLCANIC SERIES.

The grounds on which I separate the Post-Mesozoic Volcanic rocks into a Lower and Upper Series are (1) that the former was laid down after the elevation of the Desert Sandstone, but before it had suffered any considerable amount of denudation, while the latter was laid down after the former had suffered denudation, in some cases sufficient to allow of the Desert Sandstone and even of underlying formations being exposed; and (2) that since the deposition of the former, most, if not all, of the vents from which the lava was poured out have been removed by denudation, while the vents of the latter series are still extant, either as crateriform hollows, crater-lakes, or "necks," filled with plugs of basalt or ash.

To the latter (the Upper) Series belong the basaltic rocks north of Cooktown. Basalt has emanated for the most part from volcanic centres, which occur generally in the form of dome-shaped unwooded eminences near the heads of the valleys which have been denuded out of the sandstone tablelands. Conspicuous among these are the "Sisters," at the head of the Endeavour, the "Piebald Mountain," Mount Morgan (Cooktown), &c. These hills do not present a crateriform appearance, but are mere rises, marking the site of the lava eruption, which has spread around them when situated on level ground, or escaped in glacier-like *coulées* down the valleys. These points of eruption bear, in fact, such relation to the lava-flows as the similar *foci* in Auvergne bear to the basalt there. *Coulées* of basaltic lava have flowed, from the *foci* above referred to, down the Valleys of the North and South Forks of the Endeavour River, and have radiated out from Mount Morgan and other centres to the east and north, over the flats between the mountains and the sea, where they form by their decomposition a chocolate-coloured soil of great depth, peculiarly fitted for agriculture.

Where the basalt has decomposed into soil on the spot it gives rise to open, well-grassed country, almost bare of trees. Where, on the other hand, the soil has been re-deposited in alluvial flats on the sides of the river courses, it is usually covered by dense tropical jungle.

The surface of the basalt *coulées*, as well as of the dome-shaped centres of eruption, are frequently scoriaceous in a marked degree, forming spongy masses, light and porous as pumice-stone. Occasionally the basalt of the *coulées* is columnar, as at the Waterfalls in the Endeavour, between Williams's Station and Brannigan's. There the basalt is of the usual character, but contains occasional hornblende crystals and much olivine. It also contains lievrite in geodes.

Gate's Look-out is a volcanic centre of a different character—the once deep-seated stump or “neck” of a crater, which discharged showers of ashes from its mouth. It forms a conspicuous mountain of tuff, and can be seen from Isabella Creek to cut through the escarpment of a thick bed of the Desert Sandstone. The rock is an agglomerate of volcanic *débris*, with a certain rude bedding—courses of larger alternating with courses of smaller bombs—having a dip to the east at about 15°. That the bombs are not detached fragments of an already consolidated rock, but have been consolidated from a molten mass while whirling through the air, is proved by the spherical envelope of vesicular basalt which invariably enfolds them. The interior of the bombs, which range from an eighth of an inch to a foot in diameter, is a mass of black and green crystals of augite and olivine.\*

The Morgan Tableland is a fragment of the Desert Sandstone, about four miles across, and resting on upturned slates. Near its northern extremity a bald—i.e., treeless—mamelon, another of the volcanic *foci*, rises out of the slates, below the level of the Desert Sandstone. Another, which I was unable to visit owing to the prevalence of “Devil-Devil” country of a very pronounced type, was seen about three miles east of the Morgan Tableland.

Below the level of the tableland of Older Volcanic rocks, a flow of basaltic lava partly fills up the Valley of the Mulgrave River, and doubtless covers alluvial deposits. This lava must, of course, have been poured out after the Older Volcanic rocks abutting against the granitic Bellenden-Ker Range had been cut through by the Mulgrave.

In the Herberton Deep Lead, stream tin ore in considerable quantities has been obtained from a gravelly wash beneath a capping of basalt, which fills up the Valleys of Nigger Creek and the Wild River. The wash rests on granite.

Some remarks on the basalt-flows down the Valley of Reedy Brook, &c., and volcanic foci, which I suspect belong to the Newer Volcanic period, although occurring in connection with Older Volcanic lavas, will be found on page 584.

In the neighbourhood of Gunnawarra Station (Herbert River waters) “the prevailing rocks are vertical schists overlain in places by sheets of basalt, which appear to occupy portions of some of the existing valleys.” †

Besides the localities above referred to, basaltic lavas occur in the following places under conditions which show that the Desert Sandstone had been denuded before they were poured out:—

*California Creek (Tate River).*—The floor of the valley above the tin-mining township of Ord is covered by a flow of doleritic lava.

\* Report by R.L.J. on Explorations in Cape York Peninsula, 1878-9. Brisbane: by Authority: 1881.

† Report on the Coolgarra Tin Mines and Surrounding District. By A. Gibb Maitland. Brisbane: by Authority: 1891.

*Lynd River.*—A *coulée* of basaltic lava has flowed down the Valley of the Lynd. The *coulée* is two miles in width where it is crossed by the Herberton and Georgetown Road, covering the whole of the district between the Lynd and Fossil Brook. Fossil Brook is remarkable as being a strong running stream even in seasons when the Tate, the Lynd, and other larger streams in the neighbourhood are dried up. The permanence of streams in basaltic country has often been remarked. The basalt of Fossil Brook rests on gneiss rock.

*Black Springs.*—On the same road, further west, a basaltic *coulée*, about a mile in width, occupies the valley of the creek which takes its rise at the Black Creek.

*Surprise Creek.*—In the bed of Surprise Creek, and forming the plateau upon which the "Quartz Hill Hotel" (Herberton and Georgetown Road) is situated, is a highly vesicular basalt with immense geodes coated sometimes with calcite and sometimes with silica. The basalt extends about a mile from the left bank of the creek. Mr. Maitland has examined thin sections of this rock, and has furnished me with the following note:—

"A specimen collected is of a dark greyish-blue colour, and somewhat porous and vesicular. Scattered through it are yellowish grains of olivine, which often show a beautiful iridescence on fresh fractures. Under the microscope the rock is found to be made up of a granular mixture of felspar, augite, and olivine, with a little magnetite. The felspar (plagioclase) occurs in long lath-shaped crystals, and is perfectly clear and transparent. The crystals (which do not attain any great size) are remarkably free from alteration. The augite occurs in crystalline grains, and is usually of a pale brown colour, and exhibits faint dichroism. The olivine, which occurs porphyritically amongst the other constituents, has almost always undergone a certain amount of alteration into some ferriferous substance; generally the alteration is seen to commence along the external boundaries of the crystals, and to extend gradually inwards along lines of weakness. The magnetite, which is more easily detected with a magnet than under a microscope, exists as small grains of every conceivable shape. In addition to these constituents, there are long, colourless, acicular crystals of what appear to be apatite. A fair quantity of glassy matter is discernible throughout the slice. A rock of this character would be classed with the 'felspar-basalts.'"

*Einasleigh River.*—Large sheets of basalt occupy the bed of the Einasleigh River and adjacent country where the river is crossed by the Pentland and Georgetown Road, and also the valley of Spring or Lagoon Creek, near Carpentaria Downs Station, and the Copperfield River where it is crossed by the same road. Lower down the Einasleigh valley basaltic *coulées* overlie alluvial deposits older than those of the recent times, having been poured down the valley over the bed of the river, which at length cut through, or found its way through past the edge of the basalt.

It was after the denudation of the Desert Sandstone of the Newcastle Range, which overhangs the left wall of the valley, and subjacent rocks, had been carried on by the Einasleigh for at least 1,000 feet that the lava-form basalts burst out and flowed down the valley. Near the basalt a thermal spring, described in another chapter, shows that the volcanic forces which produced the basalt, though diminishing, still possess some vitality.

The basalts overlying auriferous drifts on Kroombit Gold Field probably belong to the New Volcanic series. Mr. Rands\* thus refers to these basalts:—

"Small outliers of basalt overlie the Gympie Beds on the range dividing the Kroombit and Three Moon Creek waters. A patch of basalt occurs about two miles north-west of the township [Cania], and a small outlier is seen about three-quarters of a mile south of Starlight Gully. The basalt is full of small blebs of olivine.

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\*Annual Progress Report of the Geological Survey for 1890. Brisbane: by Authority: 1891.

"That the basalt is newer than the Desert Sandstone is shown by its level and position. The Desert Sandstone once covered the whole of this district, and it must have been removed by denudation before the basalt could have occupied its present position. A large plateau of basalt occurs north of Cania Station, on the eastern side of Spring Creek."

The Basalt Wall which lies on the top of the older basalts of the Lolworth and Dalrymple area is about fifty miles in length from west to east, and forms the highest land between Lolworth and Fletcher's Creeks.

"It runs along in an east and west direction, at a distance of from two to six miles north of Lolworth Creek. The basalt is highly scoriaceous. Everywhere the cracks produced in the rock on cooling are visible, and there are immense spheroidal-shaped masses in it, also produced by cooling. The lava must have outflowed in a semi-viscous condition, for the well-known 'ropy' structure, formed by masses of semi-liquid lava rolling over and over, is very conspicuous; this structure is easily seen, even in hand specimens. The basalt consists of a groundmass of small felspar crystals, with specks of augite (?) and magnetite.

"The basalt does not form a wall in the ordinary sense of the word—that is to say, there are no perpendicular cliffs of it, but it gradually rises in steps, getting thicker and thicker as it recedes from the margin. It is destitute of any vegetation, with the exception of some plum and bottle trees and a few other scrub trees. I was informed by Mr. Clarke, of Toomba, that he had discovered some miles of well-grassed open country in the middle of this basalt. Its average breadth is about eight miles. Its general appearance is that of a recent outflow of lava, and it probably represents the latest outflow in the district."\*

It may be observed that many of the Newer Volcanic outbursts took place in the neighbourhood of areas occupied by the Older Volcanic rocks, or actually overspread the latter. Possibly the volcanic activity in some districts was continuous, but where it is possible to distinguish between an older and a newer, the two may for the present be kept apart.

Lithological observations on the basalts, &c., of this period will be found in the notes by Mr. A. W. Clarke which accompany this work.

The late Mr. Daintree classed† with the Pliocene certain alluvial deposits occurring at high levels above the Recent alluvia of the Cape River, which he thus described:—

"Whilst the recent alluvial deposits seem only to reward the miner in the immediate vicinity of some rich quartz reef or other gold matrix, this, so far as yet tested, yields gold of a rounded waterworn character, independent of any local source of supply. It differs from the first mentioned in the rounded character of the contained pebbles, its interstratified white clays, and purer waterworn gold. Isolated patches of this drift were observed from the head of the 'Cape' to the 'Lower' diggings; what had probably at one time been a continuous line of deposit having evidently been partially redistributed by the present watercourses. At the junction of 'Sandy Creek' with the 'River Cape,' a well-defined band of rounded pebble-drift joins what may, for convenience sake, be called the 'Main Lead;' this branch heads from the 'Springs' at 'Talavera's' Camp, and keeps a course between the Cape and Sandy Creek until it gains the so-called 'Main Lead,' as before mentioned. Hence, following the line of 'Gehan's Flat,' the 'White Hills' and 'Deep Lead' (the

\* Report on the Cape River Gold Field, by William H. Randa. Brisbane: by Authority: 1891.

† Report on the Cape River Diggings and the latest Mineral Discoveries in Northern Queensland. Brisbane: by Authority: 1868.

gold workings of which are all in this old rounded drift), there is no difficulty in tracing similar material in cliff sections in a south-westerly direction, until it is no longer confined within moderate limits, but opens out into a large marine or lacustrine deposit to the south and south-east.

"On the accompanying map the extent of this particular Formation is shown by the distinguishing colour 'yellow'; and on reference it will be seen that down the 'Cape' as far as the 'Lower' diggings, and down the 'Running Creek' at far as the junction of 'Golden Gully,' it may be considered as the representative of old-river channels; beyond these points to the south and east it can be regarded in no other light than that of accumulated sediment from a vast lake or sea. It has been found in working that where this supposed old watercourse is narrowest, as at 'Gehan's' Flat, 'White' Hill, &c., there the gold is most concentrated; but when it becomes broader, and the drift deeper, as on the extension of the 'Deep Lead' to the south, the gold is found to be too scattered to pay for the additional cost of mining."

Of these drifts, Mr. Rands observes\* :—"Several alluvial leads of older date than the alluvium of the present watercourses occur, and have been worked for gold. They consist chiefly of a schistose drift, with a 'wash' of coarse quartz pebbles at the bottom, and are evidently the drift of old watercourses. Some of them have given splendid returns of gold. The principal 'lead' is one running south from the Lower Cape, which averaged about 3 ozs. of gold to the load for about two miles in length. The depth of this drift varied from three feet to one hundred feet. It got wider and deeper towards the south. The gold was much waterworn and rounded. Leads of very similar character occur on the opposite side of the Cape River, at the Lower Cape, and also up Sandy Creek, near Chinaman's Gully. The Canton and Pothole Leads, at the Upper Cape, have also given handsome returns."

The late Mr. D'Oyly H. Aplin, evidently inclined to consider the "Older Alluvial" of the Gympie Gold Field as the equivalent of the Victorian Pliocene, says† :—"A stratified quartz pebble drift of older date than the existing valleys, and of which the remains now occupy the summit of ridges skirting these valleys. It is well shown capping a series of ridges on the west side of the One-mile Creek, about two and a-half miles above its junction with the River, in a large 'pocket' of the creek known as Macpherson's Paddock. It forms also a conspicuous feature on the west side of the Six-mile Creek, near the crossing of the road, about seven miles above Gympie; and has doubtless at a former period extended over a considerable area of the valley now occupied by the Mary and its tributaries. It consists almost entirely of rounded and waterworn quartz, varying in size from small gravel to boulders upwards of one foot in diameter, and intermixed with sand and clay. Associated with it are beds of ferruginous quartz conglomerate. These deposits are precisely similar in appearance, character, and position to those which constitute the 'made hills' of many of the Victorian goldfields, and which have there proved to be highly auriferous. They appear to have been almost entirely neglected or overlooked here, but are well worth the attention of prospectors, as the discovery of alluvial leads in the adjacent valleys would probably follow should the result of prospecting amongst these 'made hills' prove successful. The gold, if any, would be in a smooth, waterworn state, and entirely free from quartz—in this respect, unlike that obtained from the shallow gullies in the vicinity of the reefs."

\* Annual Progress Report of the Geological Survey for 1890. Brisbane: by Authority: 1891.

† Report on the Geological and Mining Features of the Gympie Gold Field. Brisbane: by Authority: 1868.

Of the Gympie drifts, Mr. Rands writes as follows\* :—

"An alluvial deposit occurs in many parts of the district of an older date than the deposits being formed by the existing streams. It consists chiefly of a drift of large waterworn pebbles, varying in size from half-an-inch to eight or more inches in diameter, the pebbles consisting of quartz and of hardened jasperised sandstone. There are also layers of ferruginous grit and conglomerate.

"This older alluvium can be seen in many places in the western side of the river; on some ridges on the western side of Deep Creek, about three miles from its mouth; near the Brisbane road on the Six-mile Creek; to the north of Gympie patches of it are met with here and there for the whole of the distance to Maryborough. Close to Maryborough, in the Tinana Division, a shaft that was sunk on a ridge passed through some thickness of this drift, and gold was found in one or two of the pebbles on their being broken.

"There is another alluvial deposit, probably of still earlier date, which forms a capping to the One-Mile (Red Hill) and Surface Hills in Gympie. This deposit consists of yellow and red stratified sandy and aluminous silts, with, in places, masses of pebbles and boulders of quartzite, which are well shown in the new railway cutting on the north side of Red Hill. There is no evidence as to the exact age of these deposits, beyond that they are newer than the reefs in the Gympie Beds below, as they are not intersected by them. A little waterworn gold has been found on parts of Red Hill; and on Surface Hill, in the Channon-street cutting, small nuggets of gold have been picked up. Small prospects of gold are nearly always obtained on working the soil on Surface Hill."

The Upper and Older Alluvia of the Stanthorpe tin-mining district are probably contemporaneous with similar drifts on the New England side of the border, which Mr. David classes as Pliocene.

It is quite possible that the Cape, Gympie, and Severn, and many other ancient alluvial drifts may turn out to be Pliocene, but at present we have no direct evidence to enable us to distinguish them from Post-Tertiary drifts. They probably never were covered by basaltic lavas, as any erosive agent capable of denuding the latter would in all likelihood have cleared away the underlying incoherent drifts also.

In my opinion the drifts of the Severn Valley point to a period of heavy rainfall, accompanied probably by the occasional melting of snow. A somewhat more rigorous climate than the present probably prevailed, but a careful search failed to reveal striated stones or anything indicative of a true glacial period.

Mr. Henry G. Stokes, who has collected near Oxley a number of beautifully preserved plant remains, which have been submitted to Professor Baron Von Ettingshausen for determination, has kindly given me the following notes "On the Occurrence of Tertiary Beds in the neighbourhood of Brisbane" :—

"Between Sherwood and Wolston stations, on the Ipswich Railway Line, and extending for some distance to the south-south-east of Sherwood, a series of beds occurs, consisting of pale and yellow-coloured, coarse and fine grained, argillaceous and ferruginous sandstones, sandy shales, and clays.

"The principal rock in this series is a pale-coloured variety of sandstone, consisting of an abundance of small angular and sub-angular quartz grains, and white mica, with clay, and a little oxide of iron and carbonate of lime as the cementing material. It is not a very coherent stone, and, with the exception of those portions in proximity to an intrusive rock, weathers rapidly on exposure.

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\* Report on the Gympie Gold Field. Brisbane: by Authority: 1889.



"Numerous cracks and joints divide the rock into small, rough prisms; and especially is this the case in the neighbourhood of the basaltic rock, where the sandy shales have seemingly separated into rough spheroids. The beds are traversed by a number of small faults, striking S.E., S.S.E., and S. 10 E., the largest displacement noticed not exceeding eight feet.

"As by far the greater portion of the formation is covered by alluvium, the dip of the beds and strike of the faults and joints can alone be noticed in a few localities, and where they have been exposed by denudation the bedding planes are not sufficiently defined to allow of accurate measurements being taken. The beds are generally horizontal, undulating slightly, and where they are inclined they dip at varying angles.

"In Mr. De Winton's paddock, Corinda, adjoining the river bank, this series, which is there horizontal, is seen resting unconformably on a series of coarse, gritty sandstones and conglomerate, belonging to the so-called Ipswich Beds.

"These Tertiary deposits occupy a considerable portion of the depression, extending from Sherwood, on the Southern and Western Railway Line, to beyond Runcorn Station, on the Logan Line. Outcrops of the coarse grits and conglomerates, apparently of a different geological age, occur in several places, rising above the level of the valley, forming extended ridges and hillocks.

"Most of these beds contain monocotyledonous and dicotyledonous plant remains, which may be referred to some period of the Tertiary epoch. In the shales and clays, the venation of the leaves and stems of the plants are sharply defined, and their outlines well marked in the remaining beds, but few of the impressions are well preserved, their exterior outlines being with difficulty discernible."

I have gone over the section carefully, and can see no marked lithological distinction between the strata from which Mr. Stokes obtained his fossils and many other well-known beds which unquestionably form part of the Ipswich Coal Measures; nor can I see any evidence of an unconformability of more importance than many local unconformabilities which occur in the Ipswich Beds. I should incline to regard Mr. Stokes' fossils as additions to the flora of the Ipswich Formation rather than as evidence of the presence of Tertiary strata. The whole question can, however, remain in abeyance pending Baron von Ettingshausen's determination of the fossils.

## MINES IN CONNECTION WITH THE TERTIARY ROCKS.

### RUSSELL RIVER GOLD FIELD.

This is a recently opened alluvial field which is likely to rise into importance. Its centre is about six miles west of Mount Bartle Frere. The gold is found associated with fine-grained stream tin ore in a gravelly wash beneath basaltic flows, about 2,500 feet above the sea-level. This basalt forms part of the tableland which extends from the heads of the Russell, Johnstone, and Mulgrave to the basin of the Barron near, Herberton, and is covered with dense tropical jungle and intersected by plentiful running streams. It probably dates from Miocene times, but of this no direct evidence has yet been observed. Wairambar Creek, on the west, and Coopooroo Creek, on the east, have cut through the basalt, exposing the underlying auriferous drift and the "bedrock" of slates, schists, and greywackes. Extensive preparations for sluicing the drifts have been made, and as the area covered by the basalt is enormous, and the drift has been exposed, owing to the accident of denudation, merely on the fringe of the deposit, almost unlimited possibilities are before the field. The average yield from washdirt reported in Victoria for 1883 was 1 dwt. 23.32 grains; for 1884, 3 dwts.; and for 1885, 1 dwt. 10.59 grains. I am certain that the Terraces of the Russell will give a

much higher yield than this, and there is no comparison between the extent of the auriferous areas of Victoria and those of the Russell. The Wardens have been unable to form any estimate of the alluvial gold from this field.

Gold and stream tin ore are found in the beds and alluvial flats of the Lower Russell and the Johnstone. No reefs of any importance have yet been worked in the district, and it is probable that the alluvial gold has been mainly derived from the denudation of the drifts beneath the basalt. There is, however, a rumour of a rich reef having been lately discovered.

#### MULGRAVE GOLD FIELD.

For remarks on alluvial workings, *see* Chapter XIII.

#### MOUNT MORGAN GOLD MINE.

This mine, which has already (up to 31st December, 1891) produced 907,697 ounces of gold, is not only one of the richest in the world, but presents geological features of unusual interest. It lies about twenty-six miles south-south-west of Rockhampton.

In the immediate neighbourhood of the mountain, the country-rock consists mainly of bluish-grey quartzite—a fine-grained siliceous sandstone, now more or less porcellanised—full of minute crystals of iron pyrites and specks of magnetic iron ore; greywackes of the ordinary type—hard fine-grained sandstones of mingled siliceous and felspathic materials, now somewhat indurated; and, lastly, occasional masses of pyritous shale, hardened to a flinty consistency, and a few belts of serpentine. These sedimentary rocks have been shown, from a large collection of fossils made by the late Mr. James Smith, to belong to the Gympie Formation. In the immediate neighbourhood of the Mount the sedimentary rocks appear to have been in thick beds, and they have suffered a considerable amount of metamorphism, so that their dip and strike are not easily ascertainable. The stratified rocks are, moreover, interrupted and intersected in every direction by dykes and other intrusive masses of hornblendic granite and porphyritic dolerite,\* the intrusive masses occupying nearly as much space as the remnant of the original stratified formation itself. The country-rock within a short distance of the Mount is traversed by reefs of the ordinary description, such as, for instance, the Golden Spur Reefs, the Crow's Nest Reef, and the Mundic Reef, all of which contain a pretty fair amount of gold.

The Mount is about 1,200 feet above the sea-level, or about 500 feet above the level of the Dee River, which flows past its eastern foot. The "mine" presents the appearance of a series of step-like quarries at different levels. The actual summit of the mountain has now been bodily quarried away to a depth of thirty-five feet, the level of the Second Floor.† Numbers 3 and 4 Floors are respectively thirty-five and seventy feet below the level of No. 2; and No. 5 Floor is thirty-five feet below No. 4. What is called the Crown Shaft or Main Pass is sunk from the second Floor to a depth of 155 feet, beneath No. 5 Floor. No. 2 Tunnel is driven right across the hill from north to south at the level of No. 5 Floor. No. 1 Tunnel, a little more to the west of north and east of south, is driven across the whole of the auriferous area one hundred and fifty-five feet below the level of No. 2 Tunnel, while the Freehold Tunnel is driven from east to west thirty-three feet above No. 1 Tunnel. The Sunbeam Tunnel is carried

\* *See* Notes on a Collection of Rocks and Minerals from Mount Morgan, collected by Mr. C. S. Wilkinson, F.G.S., &c.; by T. W. Edgeworth David, B.A., and William Anderson, Geological Surveyors. With an introduction by C. S. Wilkinson, Geological Surveyor in Charge. *Records of the Geological Survey of New South Wales*, ii., p. 85. Sydney: by Authority: 1891.

† Now (June, 1892) mainly to the level of No. 4 Floor.

from the south-west nearly to the Crown Shaft, and the Grass-tree Tunnel (about seventy feet below the level of the Freehold Tunnel) is driven from the south-east to the Crown Shaft.\*

The upper portion of the mountain consists of a deposit varying from red and brown hæmatite on the one hand to a frothy, spongy, cellular, siliceous sinter on the other. Fine gold is disseminated throughout the mass, but it varies considerably in richness. So far as the upper excavations show, the auriferous deposits are bounded to the south-west by a large kaolinised granitic dyke, but on No. 3 and No. 5 Floors the dyke intersects the auriferous deposits, some portion of the latter being found on its south-west side.† At the eastern end of the auriferous deposit, on the other hand, there are immense quantities of kaolinised rock, "rich in gold—i.e., from  $\frac{1}{2}$ -oz. to 22 ozs. to the ton." (Manager's Report, 1st June, 1891.) No. 1 Tunnel discloses immense quantities of highly pyritous quartzite country-rock. Indeed, there is more pyrites than quartzite.

Possessing (as will be seen from any plan of the workings) none of the characteristics of a "reef," as the term is generally understood, it becomes necessary to seek for another explanation of the origin of the auriferous deposit. I am of opinion that the gold must have been precipitated in the ferruginous and siliceous sinter deposited by a thermal spring, which, charged with chlorine, dissolved the gold from the pyrites of such reefs as the "Mundic Reef," and from the pyrites with which the country-rock beneath and around the summit of the Mount is abundantly charged. Even if the gold was present in the pyrites of the country-rock in a very infinitesimal proportion, it might be collected by a thermal spring from such pyrites over a wide area.

The occasionally angular condition of the sinter, and the tumbled condition of the ironstone masses (as evidenced by the deflection of stalactites from the vertical) would appear to indicate that explosive discharges of gases or steam occurred at intervals with sufficient violence to disturb the deposits accumulated by the thermal spring.

Mr. A. W. Clarke, of Charters Towers, late Government Mineralogical Lecturer, has favoured me with the following Note on some specimens from Mount Morgan:—

"A very large proportion of the substance is soluble in strong potash solution, the residue being nearly pure crystalline silica. This is what ought to be expected of a siliceous sinter, as, of course, the silica would be hydrated and colloidal, and the presence of some quartz (or crystalline silica) in it is quite conceivable."

Mr. Walter H. Weed, of the United States Geological Survey, who has made a special study of the wonders of the Yellowstone National Park, writes me ‡ as follows:—  
"The specimen of sinter which you enclosed is too small for satisfactory examination. It bears a striking resemblance to certain rhyolitic pumices from the Yellowstone, but lacks porphyritic crystals, while your observations regarding its occurrence render such an origin impossible, while another proof is easy in complete analysis. The sinter is not quite like anything in our collection from the Yellowstone, Iceland, or New Zealand districts. It appears, however, to be a good sinter, and its vesicular or frothy nature indicates that it was formed at the surface. As to Mr. Cameron's remarks (quoted on p. 5 of your Report of 1889), his objection to the thermal spring theory, based on the

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\* An account of later workings and developments will be found in the Writer's "Third Report on the Mount Morgan Gold Deposits." Brisbane: by Authority: 1892.

† This is also the case in the "Freehold Stopes," a few feet above the level of the Grass-tree Tunnel. See "Third Report."

‡ In a letter dated 27th November, 1889.

absence of calcareous tufa, is quite erroneous. Hot waters issuing from volcanic rocks usually deposit siliceous sinter, and that alone, the lime being carried off in solution by the waters, and usually present in very minute quantity. Calcareous deposits under such circumstances are rare exceptions,\* and not the rule. The facts described in your Report seem to offer conclusive evidence in favour of your theory."

As has already been mentioned, numerous dykes of diabasic dolerite† intersect the country-rock. Not one, however, is met with in the auriferous deposit. Had the latter been merely the siliceous skeleton remaining after the removal of the pyrites from the pyritous quartzite, the dolerite dykes would still be present to attest the original identity of the two masses. But there is at least one clear instance of a dolerite dyke intersecting the quartzite country-rock (in No. 1 Tunnel, one hundred and twenty feet north of the shaft sunk from No. 5 Floor) and not intersecting the overlying sinter (in the south branch of the Freehold Tunnel, only thirty-five feet higher); showing that the sinter and ironstone were *deposited on*, and were *not altered portions of* the pyritous quartzite country-rock. It is hardly credible that the highly auriferous siliceous and ferruginous material now being worked represents merely a weathered condition of the pyrites with which the quartzite country-rock is so highly charged, and which is so poor in gold. Again, the fact that the sinter is mainly a *hydrous* silica is an argument against its being the skeleton produced by the solution of masses of pyrites from an *anhydrous* quartzite.

For some distance around the Mount, the country-rock is frequently impregnated with aluminous, siliceous, and ferruginous material. Some portions of this rock were so far gone that on my first visit to Mount Morgan (1884) I imagined them to represent deposits from the overflow of the thermal spring, an idea which I have since abandoned, although it is likely enough that the influence of the thermal spring may have assisted in the decomposition of the adjacent rocks for some distance, and some of the easily soluble mineral matter may have percolated into the superficial portions of the adjacent rocks.

The gold of Mount Morgan is probably the purest that has ever been mined. Dr. A. Leibius, of the Sydney Mint, says it assays as high as 99·7 per cent. The gold is extracted by a process of chlorination, but its recovery from the recently discovered "kaolin ores"‡ has proved to be a much slower process than its extraction from the siliceous and ferruginous.

My reasons for classing the Mount Morgan Gold Mine as Tertiary are the following:—

"That the deposit left by the thermal spring is newer than the altered stratified rocks through which it has burst is obvious; and that it is even newer than the much later date when the dolerite dykes filled up fissures in the stratified rocks, is proved by the fact that the dykes are clearly seen in some instances to be covered over by the siliceous, aluminous, and ferruginous deposits of the spring.

"But yet another circumstance helps us in our endeavour to ascertain the age of the outburst of the Mount Morgan hot spring. About a mile to the west of the 'mountain' is a mass—apparently about one hundred and fifty feet in thickness—of horizontal bedded sandstone, undoubtedly the 'Desert Sandstone.' It rests, apparently, at this point, on a mass of diabase, but in other places it may be seen lying on the upturned edges of quartzite and greywacke strata, similar in character to those of the 'country' around Mount Morgan. The base of this Formation is a fine volcanic dust. The upper beds are coarsely gritty, and for the most part siliceous, varying from white

\* The Einasleigh Thermal Spring is one of the exceptions. See Chapter xxxvi.

† See Notes by Messrs. Edgeworth David and Anderson above quoted.

‡ The kaolin of these ores, I understand, rarely exceeds thirty per cent. of the whole, the remainder being siliceous sinter.

to brown and red, and containing occasional pebbles of quartz and quartzite. The base of the Desert Sandstone I should judge to be about a hundred feet lower than the summit of Mount Morgan.

"Standing on the sandstone cliffs, so as to look to the east, past the south side of Mount Morgan, the observer can descry, across the valley of the Dee, the familiar contour of horizontal-bedded sandstone cliffs stretching North and South. As nearly as can be judged by the eye, they are on the same level as the cliffs on the opposite side of the valley, and there can be no doubt that the valley has been carved out of a once-continuous cake of horizontal sandstone. The question arises, 'Was Mount Morgan an island in the sea or lake in which the sandstones were laid down?' In that case the hot spring was older than the Desert Sandstone.

"The answer is easily made. Had there been shores to this sea or lake where Mount Morgan now stands, the sandstone in the neighbourhood would have been full of pebbles of sinter and ironstone derived from the waste of such easily degraded rocks. But I saw none such, and I believe they do not occur. The hot spring, then, was newer, and not older, than the Desert Sandstone."\*

In many localities in the North, as may be seen in previous portions of this Chapter, the valleys carved out of the Desert Sandstone became the theatres of volcanic activity, represented by flows of basaltic lavas and "foci" filled with ash or basalt and in some instances by crater-shaped hills. Another form of volcanic activity was developed at the same period near the head of the Dee Valley. After the Desert Sandstone had been uplifted, and the carving-out of the present valleys had been carried on for long ages—in fact, till the valleys had nearly acquired their present contours—basaltic lava flowed down the valleys over the upturned slates of the MacIvor and over the auriferous drifts of the Mulgrave, and a thermal spring of enormous proportions burst out, or perhaps even a geyser spouted fitfully in the valley of the Dee, carrying with it not only water, but in all probability chloride of gold.

The literature of Mount Morgan is already voluminous. The reader may consult —

- (1.) LEIBIUS, A.—Notes on Gold. *Journ. R. Soc. N. S. Wales for 1884* [1885], xviii., p. 37.
- (2.) GREGORY, A. C.—Observations on the Occurrence of Gold at Mount Morgan. *Proc. R. Soc. Queensland*, 1884.
- (3.) JACK, R. L.—Report on the Mount Morgan Gold Deposits. Brisbane: by Authority: 1884.
- (4.) *Id.*—Second Report on the same. Brisbane: by Authority: 1889.
- (5.) MACDONALD CAMERON, J.—Report on Mount Morgan, to the Directors, dated 26th March, 1887, reprinted in *Rockhampton Bulletin*.
- (6.) RICKARD, T. A. (*of California*).—Mount Morgan Mine. Articles in *Melbourne Evening Standard* for 13th and 14th March, 1890.
- (7.) SYKES, WILLIAM H.—A Practical Treatise on Mount Morgan. *Mount Morgan Chronicle* Office, 1888.
- (8.) WILKINSON, C. S.; DAVID, T. W. EDGEWORTH; and ANDERSON, WILLIAM.—Notes on a Collection of Rocks and Minerals from Mount Morgan, already quoted. (*See* page 598.)
- (9.) Mine Sections and Working Plans issued by the Directors, July, 1890.
- (10.) JACK, R. L.—Third Report on the Mount Morgan Gold Deposits. Brisbane: by Authority: 1892.

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\* Report (First) by R.L.J. on the Mount Morgan Gold Deposits. Brisbane: by Authority: 1884.

## MOONDILLA GOLD FIELD.

Although widely different in its physical aspects, this Goldfield belongs, I am fully persuaded, to the same category as Mount Morgan, representing another phase of the activity of thermal waters, probably manifested at or about the same period of time.

The "Goldfield" occurs on the dividing line between Gumbardo and Milo Runs, in the middle of nearly dead-flat mulga-covered pastoral land. What may be called the "bed-rock" of the district is the "Rolling Downs" or "Lower Cretaceous" strata, which have already been described. This is covered by the material about to be described, and which can be identified as derived from the *débris* of the Upper Cretaceous or Desert Sandstone, of which denuded fragments occur in the neighbourhood.

The groundwork of the field consists of what is known as "cement," a somewhat consolidated "wash" of materials for the most part siliceous, but to some extent felspathic. This cement, on being broken up and washed, is found to contain a considerable quantity of hydrous silica, which is not in rounded waterworn grains, but in concretions or nodules. Sometimes the silica, when present in large quantities, forms lenticular concretionary masses, and even what may be called beds, strata or seams interstratified with the cement. When these beds attain any thickness they present almost every variety of the chalcedony group of hydrous silica, varying in colour from smoky to yellow, pearly, milk-white, and water-clear, and, while breaking with great facility (with a conchoidal fracture) into "knives" or "flint-flakes," can be seen on every surface and in every thin section to have a nucleated structure throughout.

The above characteristics, and above all its low specific gravity, would enable any miner to distinguish this from the auriferous stone of any hitherto known goldfield. The low specific gravity is, of course, due to the fact that water enters into its composition, so much of it as is water being only two-fifths of the weight of an equal bulk of common anhydrous quartz.

If it be permissible mentally to reconstruct the conditions under which the Goldfield was created, we may imagine, in the first place, a land surface on which the Upper Cretaceous (Desert Sandstone) lay on the Lower Cretaceous (or "Rolling Downs") strata. In course of time the Desert Sandstone was denuded till mere fragmentary tablelands of it remained *in situ*, the *débris* of the portion removed being spread over the surrounding low country. From abundant evidence furnished by other parts of Australia, it is known that at a period (Newer Tertiary ?) when the denudation of the Desert Sandstone had gone on for some time, immense outbursts of volcanic activity took place, giving rise in some cases to flows of basaltic lava, and in others to fountains of warm water. We may presume that the latter was the case at Moondilla, and that the water was highly charged with dissolved silica, of which it carried quantities into the then loose and incoherent masses of *débris* formed of the waste of the Desert Sandstone. The silica, at first in a gelatinous condition, would eventually be segregated into concretions surrounding nuclei or filling up spaces or openings in the bedding-planes, and on consolidating and crystallising would have no difficulty in elbowing portions of the cement matrix out of the way and assuming the gnarled and twisted forms presented by the majority of the concretions and seams. In all probability the thicker beds of silica represent pools of silica-charged water, which were ultimately covered up by further accessions from the *débris* of the Desert Sandstone. With the silica a limited amount of gold appears to have come up in solution, and to have been deposited with it, possibly precipitated by the agency of sulphate of iron. The portions of the silica richest in gold are those which are seamed with iron oxide.

The silica occurring in the cement has evidently had a similar origin to that which forms comparatively thick beds. It is not waterworn, and has not been carried by

running water, but is concretionary—the result of the segregation, around nuclei, of a certain amount of the same material, once more widely disseminated throughout the surrounding mass. There is no reason to suppose that the gold, any more than the silica, was carried from a distance, or emanated from any reef which may be discovered by trenching or sinking.

The following, from a trench in “No. 1 East” Claim, may be taken as a typical section:—1, Red soil, 1 foot; 2, Silica, 1 foot; 3, Cement, with bands of silica, 3 inches; 4, Cement, with horizontal lines of cavities, a yellowish stain, and small concretions of silica, 1 foot 8 inches; 5, Silica, 0 to 3 inches; 6, Same as No. 4, 10 inches; 7, Cement, with bands of silica, sometimes coming together into a thick bed, 1 foot 8 inches.

The silica beds sometimes attain a thickness of three feet, and in some cases thin out rapidly, so that it would be impossible to say, without continuous working, whether beds seen in shafts a few yards distant are identical or not. On the “Range” (an almost imperceptible rise, perhaps six feet above the general level of the flat), the first silica bed is generally met with within three feet of the surface; but some shafts have not met any thick bed. The deepest shaft, when I visited the place in company with Major Moore, the Warden for the District, in September, 1891, was fifteen feet.

Before I left Brisbane for Moondilla, I was permitted to see a parcel of specimens, apparently rich in gold. The stone was unquestionably of the same unusual character as that which I subsequently saw stacked in large quantities on the Field itself, although in the latter I could detect no visible gold. After much careful pounding and washing, a very few “colours” were, however, obtained. It is now said that the specimens exhibited in Brisbane had fine gold ingeniously plastered on them. I retained only one of the Brisbane specimens, showing a minute speck of gold, and the latter, after the lapse of ten months, has *disappeared*. I have been unable to obtain a sight of the other specimens. There can be little doubt that the short-lived “Moondilla rush” was the result of a rascally case of “salting.” The visit of inspection had the effect of preventing further mischief, as the Warden agreed with me that the “prospects” did not warrant the proclamation of a Goldfield.

The Moondilla country is, in ordinary seasons, a very dry one, but, the geological conditions being favourable to the discovery of artesian water, infinite possibilities of profitable working are open should payable gold be found. Even as it is, I consider that the discovery of gold although in minute quantities must attract attention to the presence of the precious metal under conditions which are certainly new, and which may yet prove to be of importance, as a similar formation to that of Moondilla is reported to cover extensive areas in the West.

J.

## CHAPTER XXXVI.

### POST-TERTIARY AND RECENT. THERMAL AND OTHER SPRINGS.

#### STANNIFEROUS DRIFTS, VIZ.: STANTHORPE, MOUNT SPURGEON, AND PASCOE TIN FIELDS.

Sir Thomas Mitchell, in January, 1842, sent to England some specimens of *Diprotodon* "from the Condamine River, in Lat. 28° S., Long. 150° E." It is evident that the Latitude and Longitude are wrong, and Mr. George F. Bennett concludes \* that the part of the river's course referred to must be between Leyburn and Yandilla.

Leichhardt is quoted by Mr. Bennett † as having written, *apropos* of some fossils sent home by him on 10th July, 1844, from the Darling Downs:—"The plains are filled by an alluvium of considerable depth, as wells, dug fifty to sixty feet deep, have been sunk within it. The plains and creeks in which fossils have been found are—Mr. Hodgson's Creek, Campbell's Creek, Mr. Isaacs' Creek [Gowrie Creek], and Oakey Creek. They pass all into and through immense plains on the west side of the Condamine, into which they fall. The bones are either found in the bed of the creek, particularly in the mud of dried-up waterholes, or in the banks of the creek, in a red loamy breccia, or in a bed of pebbles, containing many trachyte pebbles from the Coast Range, from the west side of which these creeks descend."

In his "Journal," Leichhardt wrote ‡ in the end of September, 1844:—

"We passed the stations of Messrs. Hughes and Isaacs, and of Mr. Coxen, and arrived on the 30th September at Jimba [Jimbour?], where we were to bid farewell to civilisation.

"These stations are established on creeks which come down from the western slopes of the Coast Range . . . and meander through plains of more or less extent to join the Condamine River. . . . These plains have become remarkable as the depositories of remains of extinct species of animals. . . .

"Mr. Isaacs' Station is particularly rich in these fossil remains; and they have likewise been found in the beds and banks of Mr. Hodgson's and of Mr. Campbell's Creeks, and also of Oakey Creek. At Isaacs' Creek [Gowrie Creek] they occur together with Recent freshwater shells of species still living in the neighbouring ponds, and with marly and calcareous concretions, which induces me to suppose that these plains were covered with large sheets of water, fed probably by calcareous springs connected with the basaltic range, and that huge animals, fond of water, were living either on the rich herbage surrounding these ponds or lakes or browsing upon the leaves and branches of trees forming thick brushes on the slopes of the neighbouring hills."

Mr. George F. Bennett (son of Dr. George Bennett, of Sydney, and an enthusiastic naturalist and collector of Darling Downs fossils), in the Paper above referred to, gives the following notes:—

"The bank of Gowrie Creek, from the Gowrie Junction Railway Station until it goes into Westbrook Creek, is more or less rich in fossils. The portion from the

\* Notes on Rambles in Search of Fossil Remains on the Darling Downs. [1876.] *Queensland Philosophical Society's Annual Report* for 1877.

† *Loc. cit.*

‡ *Journal of an Overland Expedition in Australia*, p. 1. London, 1847.



junction to the Railway Bridge, Dalby Line, has only had a few stray bones found in it, as the black soil there is very deep, and, in my opinion, the strata containing the fossils are only just now becoming exposed; but from thence to the boundary of Gowrie is very rich.

"To return to the consideration of the localities in which fossil remains are to be found, I think I can put the boundaries pretty well from Gowrie to Spring Creek, Clifton (none are recorded as being found in Dalrymple Creek, on the Warwick side of Spring Creek); thence to the Condamine River, and along its eastern bank as far as Chinchilla (where I have seen specimens embedded in the rock). These boundaries include Eton Vale, Clifton, Pilton, Gowrie, Yandilla, Cecil Plains, St. Ruth, Jimbour, and Warra Warra, Jimbour Station being the northern boundary."

Mr. Samuel Stutchbury refers\* to "the cementation of drifted matter [on the Darling Downs] such as pebble, shingle, frequently containing fragments of the bones of extinct animals, many of them being much abraded by rolling, whilst others, together with the exuvia of fresh-water mollusks of existing species (the Unios only differing from their having attained a larger size and thickness), are found drifted together with little or no injury, and cemented by calc-sinter, calcareous tufa, and travertin." He adds: "Bones have been found at all the various depths at which the alluvial soil of the plains has been penetrated, even from wells at a depth of sixty or more feet, as was the case in sinking a well at Nombi, on the Liverpool Plains; therefore, the race of animals now extinct must have existed throughout the period of time necessary for the accumulation of the vast amount of alluvial drift; or the drift must have undergone many mutations, by being swept away and being redeposited."

In a later Report† Mr. Stutchbury mentions the following localities from which bones of extinct animals have been obtained:—King's Creek, Emu Creek, Hodgson Creek, Clifton, Gowrie Creek, Myall Creek, Bowra Creek, and Dalby. From this Report the following stratigraphical notes are taken:—

"King's Creek presents a succession of waterholes, circular, oval, and linear, and exhibits on the banks, by successive layers of shells, distinct periods of deposition; this is particularly apparent near Clifton, the bed of the creek being composed of a peculiar conglomerate made up of debris containing shells, bones, &c., and cemented with lime; fossil trunks of coniferous trees upon the same level were observed *in situ* as if cleanly sawn; above this the deposits of different periods may be clearly traced."

"Crossing Gowrie Creek, I proceeded to the junction of Oakey and Pitt's Creek with Westbrook Creek; the banks in many instances exposed a reddish marble containing calcareous tufa and fragments of bone.

"I was shown at Dalby the jaw of a wombat (*Phascolomys Mitchelli*) and other larger bones, obtained at a depth of sixty feet from the surface while sinking a well. The fact of bones being found at such depths, while in other places they are near the surface, would, at first sight, appear to be evidence of their having existed throughout the period of time necessary for the deposit of sixty or more feet of alluvial matter. This, I presume, is not the case, but that their being found at such depth results in [from] the watersheds [water-channels] having altered their courses, and carrying the bones with the other drift, and filling up and levelling some large waterhole; the bones, from their size and lightness, being the first deposited."

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\* Eleventh Tri-monthly Report upon the Geological and Mineralogical Structure of New South Wales. Sydney: Legislative Council Papers: 1853.

† Twelfth Tri-monthly Report, &c. Sydney: Legislative Council Papers: 1854.

In 1869 the late Rev. W. B. Clarke reported \* the discovery of a femur of a Struthious Bird, subsequently named by Owen *Dromornis australis*, at the depth of 188 feet in drift resting on granite, from a well in that part of Peak Downs which lies between Lord's Table Mountain and the head of Theresa Creek, near the track from Clermont to Broad Sound. The bone was found in a deposit of drift pebbles and boulders one hundred and fifty feet thick, overlaid by thirty feet of black trappean alluvial soil.

In the same communication, Mr. Clarke says, "In some of the creeks running more to the south-eastward from the Peak Downs, and, like Theresa Creek, belonging to the McKenzie River system (e.g., Crinum Creek), occur bones of *Trionyx* and *Crocodylus*."

The late Mr. R. Daintree, in his Paper on the Geology of Queensland,† says:—

"From the Gulf of Carpentaria, in the north, to Darling Downs, in the south, the fossil remains of extinct mammalia have been found in breccias and indurated muds, which are representatives of the beds of old watercourses, through which the present creeks cut their channels. At Maryvale Creek, in Latitude 19° 30' South, good sections of these old brecciated alluvia occur. The fossils from this section, as determined by Professor Owen, are:—*Diprotodon australis*, *Macropus Titan*, *Thylacoleo*, *Phascolomys*, *Nototherium*, Crocodile teeth, &c.‡

"Imbedded in the same matrix occur several genera of mollusca of species undistinguishable from those inhabiting the Maryvale Creek. My friend and late colleague, Mr. Robert Etheridge, jun., has compared these with the Recent forms, and finds them to consist of—

"GASTEROPODA.—*Melania pagoda*, *M. arca*, *M. subimbricata*, *M. mæsta*, *M. sp.*, *Limnæa rimosa*, *Physa truncata*, *P. sp.*§

"LAMELLIBRANCHIATA.—*Corbicula australis*; *Unio*, sp.

"The fact of these older alluvia forming both the bed and banks of the present watercourse . . . goes to prove that *Diprotodon* and its allies inhabited the Queensland valleys when they presented little difference in physical aspect or elevation from that of the present time. The Crocodile (*Crocodylus australis*), however, had then a greater range inland than it has now.

"A study of these *Diprotodon*-breccias leads to the conclusion that the remains were chiefly entombed in what were the most permanent 'waterholes' in seasons of excessive drought, and that the animals came there in a weak and exhausted state to drink and die, just as bullocks do under similar conditions at the present time.

"No human bones, flint-flakes, or any kind of native weapon have yet been discovered with the extinct mammalia of Queensland."

In his Report "On the Geological Features of the South-eastern District of Queensland," || Mr. A. C. Gregory gives the following description of the "Older Alluvial or Fossil Drift":—

"The deposit is restricted to the valleys descending westerly from the main range dividing the waters flowing to the east coast from those which flow westerly to the Darling and Murray Rivers. Its limits are not well defined; but it forms the banks of the present watercourses, near the summit of the range, and extends down them to the

\* Geological Magazine (1869), iv., p. 383.

† Quart. Journ. Geol. Soc. 1872, xxviii., p. 274.

‡ List corrected by my Colleague (see Post-Tertiary Organic Remains) as follows:—*Crocodylus porosus*; *Diprotodon australis*, Owen; *Macropus Titan*, Owen.

§ List corrected by my Colleague (*Ibid.*) as follows:—*Corbicula nepeanensis*, Lesson, *Melania onca*, Adams and Angus, *M. balonensis*, Conrad, *M. denisoniensis*, Brot., *Limnæa vinosa*, Adams and Angus, *Physa truncata*, H. Adams.

|| Brisbane: by Authority: 1879.

level plains near the banks of the Condamine River, where it appears to attain a depth of more than a hundred feet, as fragments of bones have been obtained at that depth in sinking wells.

"It may, however, be observed that, though the fossil drift is only found on the western waters in Southern Queensland, there are rich deposits in bone drift on eastern waters of Peak Downs in the central district.

"This alluvium is remarkably rich in fragments of bones of extinct animals, including *Diprotodon australis*, *Macropus Titan*, *Thylacoleo*, *Phascolumys*, *Nototherium*, &c.

"The bones are associated with fragments of shells of *Unio* and other fresh-water mollusca similar to those now found in the present watercourses, but more massive in structure, basaltic pebbles, sand and mud, the stratification of which indicates intermittent currents flowing down the present valleys, such as now result from the annual rainfall, but of much greater volume.

"Although the greater part of the bones are broken into fragments, and show evidence of being drifted and waterworn, there are some which prove that many animals cannot have been deposited before decomposition in the localities where their remains are now found grouped together.

"The general condition under which the bones are found indicates that what are now broad valleys and plains were originally extensive marshes with watercourses flowing westward into lakes, and that the gradual filling up of the lake-beds with drift, and the deepening of the channel of the Condamine River which drains the country, conjoined probably with a gradual decrease in the annual rainfall, have combined to change a swampy country covered with coarse, weedy vegetation into open downs and plains producing short grasses totally inadequate for the support of animals with the heavy frames and peculiar teeth which characterised the majority of the ancient occupants of the district.

"There is no trace, either in the Darling Downs or any other part of Queensland, of any violent convulsion of nature which would be adequate to cause the total destruction of the *Diprotodon* and co-occupants of the country, and it seems most probable that their extinction resulted from a gradual change of climate and more effectual drainage through the deepening of the channels of the watercourses—aided, perhaps, by some slight changes of level. Few satisfactory traces have been found of the vegetation of this period, though some fragments of what appear to have been woody seed-vessels are met with in the bone drift, but their condition is not sufficiently perfect to admit of any definite conclusions. The general character of the vegetation may, however, be surmised from the form of the animals, the structure of their teeth, and the mode in which they are worn by feeding on it. These data suggest coarse reeds and aquatic plants, such as would be too succulent and liable to rapid decay for their preservation as fossils, while the absence of wood and ferns, which are so abundant in the older coal strata beneath, indicates that there was little or no forest.

"One remarkable feature of the older alluvium is that the fossil bones are only found in the detritus of the basaltic rocks. Alluvium of the same age, derived from the Carbonaceous and Devonian Series, have not as yet been found to contain remains of the extinct animals. This may have resulted from the superior fertility of the basaltic lands, which would be capable of producing abundance of food, while the comparatively sterile soil derived from the older formations would not furnish suitable vegetation for the sustenance of the massive quadrupeds of that era."

The occurrence of *Diprotodon* in the auriferous drift of Gogango Creek, near Rockhampton, is noted by Mr. Daintree in his "General Report on the Northern

District."\* This specimen was said to be in the possession of Mr. John Jardine, Gold Commissioner (now deceased). Gogango, according to the Railway Survey, is only three hundred and fifteen feet above sea-level.

A portion of a lower jaw of a *Diprotodon*, pronounced by Dr. E. P. Ramsay, Curator of the Australian Museum, Sydney, to be probably the young of *D. australis*, or perhaps a new species, was found by Mr. T. Buckland on the bank of the Burdekin, opposite Gilgunyah Station. A cast is in the Geological Survey Museum.

Taking the Maryvale, Burdekin, Peak Downs, and Darling Downs localities, from which remains of the extinct mammalia have been obtained, it will be seen that all these places are at considerable elevations, none of them being less than 900 feet above the sea-level. Caiwaroo, where Mr. Cotter's fossils have been obtained, must be about 400 feet above the sea. The doubtful instance of Gogango Creek would, however, bring the fossils down to 315 feet. The only instance of which I am aware of remains of the extinct mammalia having been obtained near the sea-level is that of the Eight-mile Plains, near Brisbane.

There is abundant evidence† to show that in the southern Colonies the extinct mammalia existed in Pliocene times. On the other hand, in Queensland there is no evidence that they went back to the Tertiary Epoch, although it is quite possible that they did. Such direct evidence as we have, consisting of the association of the mammalia with fresh-water and land shells of species still living, would lead to the conclusion that the former were, in the Queensland area, confined to the Post-Tertiary deposits. Still, considering how imperfect is our knowledge of the Tertiary in Queensland, we may well be prepared for the production of fresh evidence on this point.

The introduction of the peculiar Mammalian and Avian Tertiary and Post-Tertiary Fauna into Australia is one of the most puzzling problems offered by geological history. Mr. Alfred Russell Wallace says:—

"Marsupials are almost certainly a recent introduction into South and North America from Asia. They existed in Europe in Eocene and Miocene times, and presumably over a considerable part of the Old World; but no trace of them appears in North or South America before the Post-Pliocene period."‡

It must not be understood that the first appearance of marsupials in Europe was in Eocene times, as they are known as far back as Triassic. The migration of marsupials from Europe and Asia to America may have been accompanied or preceded by a migration from Asia to Australia by way of a land connection formerly existing. At any rate, marsupials make their first appearance in Australia in Pliocene times, and in great force. There is no palæontological warrant for the supposition that they originated in Australia. The migration of marsupials does not appear to have extended to New Zealand, although a land connection seems to have existed in Cretaceous times, but not later.§ The wingless birds of New Zealand and Australia, both fossil and recent, present evidences of former connection; but as their avian ancestors may have possessed the power of flight and even of swimming,|| their distribution may have been more rapid than that of the mammalia, and may have extended to New Zealand before the land connection was cut

\* Page 4. Brisbane: by Authority: 1870.

† Notes on the Geology of New South Wales, by C. S. Wilkinson, p. 57. Sydney: by Authority: 1882.

‡ Geographical Distribution of Animals, i., p. 155. London, 1876.

§ Professor Hutton. "On the Origin of the Fauna and Flora of New Zealand." *Presidential Address to the Philosophical Institute of Canterbury*, 1st November, 1883, Pt. i., p. 17.

|| See A. R. Wallace, p. 451. *Island Life*. London, 1880.

off. The generic and specific distinctions between the marsupials and the wingless birds of the Old and New Worlds and of Australia and New Zealand may have arisen during the progress of migration, and may have been further developed by the insulation which Australia and New Zealand subsequently attained.

The extinction of the same fauna, which had a, geologically speaking, brief existence in Australia, has been accounted for by Professor Owen and Professor Tate by the intervention of Man; and by the late Mr. C. S. Wilkinson by the supervention of the present arid climate on a period of heavy rainfall, which there is evidence to show occurred, after Pliocene times.\* Mr. Wilkinson argued that heavy rainfall and consequent luxuriance of vegetation were necessary for the support of the numerous and in some cases gigantic animals of which we have now only the fossil bones. Darwin has, however, shown † in the most striking manner that the regions which in the present day support the largest and most numerous quadrupeds are by no means those which are most remarkable for luxuriance of vegetation; nor, conversely, are the regions now most characterised by luxuriance of vegetation the favourite haunts of large animals. As for the intervention of Man, it will be seen in a succeeding page that the evidence in favour of his existence in Australia coeval with the extinct Post-Tertiary Fauna is at least doubtful.

I do not mean to advance a thesis which I am prepared to defend against all comers, when I suggest that the extinction of the Post-Tertiary Mammalia, &c., may have had something to do with the subsidence afterwards referred to,‡ but simply draw attention to a factor which appears to have been overlooked. It is not unreasonable to suppose that changes of climate followed, on the subsidence of the land, sufficiently great to have a disastrous effect on the now extinct fauna. It is also possible that when the shores of the Great Australian Bight were ground down by ice, the climate may have been too rigorous for their existence even on the Darling Downs and the tropical portions of Queensland.

### CAVES.

None of the Caves which penetrate the limestones of Queensland have yet been systematically explored. They may yet prove as interesting for their imbedded organic remains as the Wellington Cave itself. Some of these caves may be here described:—

The limestones of the Chillagoe District (Gympie Beds?) are remarkable for the number and size of the caverns which have been excavated. I was informed by Mr. H. G. Livesey, of Irvinebank, who has made numerous admirable photographs of the scenery of this remarkable region, that at least thirty caves are already known. I visited, under the guidance of Mr. W. Atherton, of Chillagoe Station, the cave known as "The Temple," which occurs in one of the limestone ranges on the left bank of Chillagoe Creek, about two miles from the Station. Entering by a lofty opening on the western side of the range, we walked erect for perhaps sixty yards, and then found ourselves in a magnificent theatre, about one hundred feet in diameter and some eighty feet high. The cupola-like interior was lighted from the top by a hole which had an area of perhaps two hundred square feet. The roof was festooned with stalactites, while the floor was covered in places with stalagmite. Occasionally these met, forming long and graceful columns. But the stalactites and stalagmites were rarer than is

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\* Anniversary Address to the Royal Society of New South Wales, 2nd May, 1888.

† Journal, Voyage of H.M.S. "Beagle" Round the World; Chap. v.

‡ See remarks on the depths of the drifts in the neighbourhood of Townsville.

usually the case in limestone caves, this circumstance probably pointing to the dryness of the climate. The greater part of the floor was deeply covered with drab-coloured "cave-earth," representing probably the insoluble argillaceous impurities of the limestone. Shells of *Helix*, in all stages of incrustation by lime, were plentifully scattered over the floor in some places—probably the sites of pools in wet weather. On one side of the "theatre" a dark recess opened out, its lower half blocked by a nearly flat limestone boulder, in front of which a row of stalactites depended from the roof like a partially uplifted curtain. Perhaps the most picturesque aspect of the cave was that seen from behind the stage, looking past this screen into the proscenium. A narrow passage behind the stage led to other caves, some at lower and some at higher levels. One of these must have been at least two hundred feet in length, and fifty feet in width, with a gothic roof eighty feet high. There were many nooks where the stalactites were little thicker than pencils, and arranged in groups of exquisite beauty. Very few of them had, at the date of our visit, the drop of water which one expects to find in such a position. From a few, drops of water fell at very long intervals. The floors of the caves appeared to be about on a level with the surrounding country, and, according to Mr. Livesey, this is usually the case with the caves of the district.\*

The Middle Devonian Limestone of the Broken River, a tributary of the Clarke, contains numerous caves, from the detritus on the floors of which gold is said to have been obtained.

The limestone beds of the same age near the Fanning Station also contain beautiful if not large caverns, adorned with stalactites.

The caves in the limestones of Raglan and Langmorn, Port Curtis, have been described by the late Mr. James Smith† as large and picturesque. Mr. Smith has obtained from the stalagmitic deposit on the floors some fragments of bones, still undetermined, together with recent land shells, and has also noted the occurrence of a deposit of stalagmite, containing fossil bones, from which the limestone that formerly enclosed them has been entirely weathered away.

In the neighbourhood of Rockhampton numerous caves occur in the immensely thick limestone beds of the Gympie Series. Some of these were explored to some extent by Mr. Smith, whose descriptions (somewhat condensed) are quoted below. Making every allowance for Mr. Smith's well-known enthusiasm, it is evident that the caves are worthy of systematic and scientific investigation.‡ It may be added that Mr. Smith's determination of species may be incorrect, and in point of fact my Colleague does not adopt them, as further collections will be made.

*Olsen's Caves.*—"Traversing these long, extensive subterranean passages, lofty galleries, spacious chambers, and wide spanning arches, by the light of a candle that but reveals the gloom, you cannot help becoming possessed with a sense of solemnity and awe in the presence of Nature's mysteries. But these walls are not of a black and ghastly funereal hue. They are everywhere of a neutral tint of shaded white, abundantly tapestried with encrusting inflorescence, panelled with curiously-carved pendent and planted alabaster decorations, and clothed with many hangings of petrified cascades, entirely made up of minute hexagonal, needle-pointed, reversed crystals of purest calcite. Do these caves contain any records throwing any light on the conditions of local former life? This is a problem that will provide occupation for many labourers for long years to come.

\* Report by R.L.J. on the Chillagoe and Kooboorra Mining Districts. Brisbane: by Authority: 1891.

† MS. notes.

‡ Mr. W. H. Rands has recently examined the Caves, and his Report will shortly be published.

"What has been done already is interesting enough, but nothing very strange, wonderful, or startlingly new as yet. The shells and bones locked in the stalagma and those found loose in the bat exuviae are identical with those of existing species. Casts of fossil millipedes are among them.

"The first new cave is in a low mound, a few hundred yards to the left of the big hill. You descend a deep, narrow shaft by means of a rope half-way, and there is a further descent by leaping from one projection to another, in a slanting direction, till you come to the bone-bed. There is no foul air; ventilation seems to come from another opening, but there is the closeness of the charnel-house, and the mustiness of the tomb. The bones are the remains of a large Kangaroo. The leg bones are sixteen inches, and thigh bone ten inches. The lower jaw was originally ten inches long. I did not see the skull. They are very decomposed and crumbly. I think the animal must have fallen down the shaft, and floundered along in its uninjured state to the centre of the deep cave where it was lying. In the other new caves adjoining, a complete skull of a Native Cat, with its retractile teeth, and several Wallaby and Opossum skulls, with other remains, were found. These bones are now on view at the School of Arts, Rockhampton.

"The beauty, cleanness, variety, and number of the ornaments in these new vaults far exceed anything to be found in the larger caverns. These are the realisation of the works of the most wonderful genii of our youth, the elaborate grottos of the fairy tales. Ladders are to be placed so that they may be reached, and, above everything, they ought to be wire-netted.

"The increasing value of what was once termed 'the waste lands of Australia' suggests attention to her waste products. Contemplation of the vast mounds and deep deposits of the bat manure, mixed with the pulverulent lime marl in these caves, points to large sums of money that may be realised from their utilisation. From what I have read of what is being done with this substance in other places, its value is sufficiently established."\*

*Johannsen's Caves.*—"These caves are situated contiguous to our local 'Mount Etna.' They are in a great mountain of compact limestone—a grey, dense marble, exactly corresponding to the rock of Gibraltar, hard, homogeneous, and unstratified, but cracked and tilted in thick irregular beds. The outside weathering is of the usual sharp-pointed, pock-pitted nature all these formations throughout the district present to the eye. All round the base of the mountain are the usual fallen masses, and the numerous lumps of thin stratified stalagma among them tell how cave action has reduced the hill to half its former size. The chief entrance is greatly blocked up by the fallen roof of a former cave. One feature of Johannsen's Caves is their narrow entrances, and their wide swelling proportions inside. You crawl and creep through a 'hole in the ground' that hardly admits you, and in a moment you may walk for six solid hours through the great squares, wide streets, intricate labyrinthian mazes, circling wynds, courtyards, and lanes, 'through-gaun closes' of a great subterranean town with surrounding suburbs. The architecture is entirely gothic, of cathedral form; and the strong impression besets you that you have stumbled on the ruins of a mediæval city. The black gloom of these lofty corridors, of which no candle can show the roof, and the great groined arcades, with rear aisles, deep secret recess-arched alcoves, and hanging rock-flitches, must be seen to be appreciated. They beggar description.

"One of the geological points is a black bed-crack circling round all the central caves, about the height of a man's head, showing that in former times the whole

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\* *Rockhampton Bulletin*, 12th October, 1886. Mr. Randa, who has since visited the caves, does not think that the bat manure can be profitably worked.

formation was connected together like solid steel, and that the whole thing has been slowly cut out of the cracks and crevices by the agency of water percolation, holding a modicum of carbonic acid in solution.

"The tale of the economic value contained in these caves may well come in here. Capitalists, sighing for profitable investments, sink to the knees at every step in the most fructifying of all materials, consisting of deep deposits of bat exuviae that must have taken millions of years to accumulate, mixed with a flocculent lime powder that slowly drops from the rock faces, and is the undoubted agency that has melted them away. If all this be true of mere naked nothingness, enormous vacuity, black and murky midnight darkness, what shall be said when you begin to see these walls clothed in snowy whiteness, the niches filled with the nicest carved statuettes, the arched alcoves framed in the most unique of alabaster pilasters, the floors studded with the rarest forms of marble columns, the roofs an inverted forest of pendent cones, and the *tout ensemble* a glittering mass of saccharine, granular, glancing, acicular crystals, beyond the power of pencil to paint, designer to plan, or heart to conceive.

"Our party was the first of the public to conquer the 'deep sink.' Progression was like gasteropods, and, feet foremost, through the narrow tunnel, deep down a series of perpendicular ladder-flights, lashed together with iron wire. At the bottom of this series of caves there is a burst of exclamation of mingled astonishment, rapture, and delight. The wide floor is covered with shells, like a sea shore, crunch-crunching at every step. But the chief feature is a perennial bubbling fountain, like a cold-water geyser, that has built a wide mound, in a succession of tiny terraces. The structure of these overflowing circles is of the cellular rhomboid form of the inside coating of a bullock's stomach, and has been named 'tripe-stone.' From numerous dried-up formations of this shape, throughout all the caves, we have the evidence of very much of this work having been done in the past. It is a petrifying spring. The water is as clear as glass, as cold as ice, tasteless, and palatable. This is where the fossils are found; and the samples show every stage of the process—the bright bands of the scrolled shells beginning to be coated, others deeply incrustated, and some turned to balls of solid marble. The teeth in the skulls and the incrustated shank bones are very remarkable and deeply interesting, for these are the things that Science asks for, and care will be taken that they will be placed in proper hands. Any object you desire to be turned into stone, from a human being to a spider's web, has simply to be immersed for a time on the shelves of these terraces, in that lime-water.

"But Nature has built the most handsome of all her ornaments, the chastest, most delicate, superb, and beautiful of these cave treasures away up in the most secret recess of the 'benmast bore.'

"As high up again as you have descended, overhead high benches and long, sloping moraines—in an upper corner a great cluster of twin wavy, stalasso, in projected canopy, semi-circular form, joined to the wall with the widest, deepest, folded curtain drapery of the most curious dendritic weaving that ever eyes saw.

"We visited the Crystal Cave, replete with the most magnificent slabs of compressed, pure calcite crystals."

Mr. Smith sent me a small collection (now in the Geological Survey Museum) of bones dug by him from the stalagmitic floor of Johannsen's Cave, together with the following notes by Mr. C. W. De Vis, dated 1887:—

Nos.

184. Chip from inner fore side of right radius of *Horse*.

185. Right femur of young Kangaroo Rat (*Hypsiprimnus* sp.). Unless the Rockhampton species differs much from the common *H. rufescens* and *H. Greyi*, this bone is significant.



Nos.

186. Right side of pelvis, hardly distinguishable from that of *Halmaturus temporalis*, the Moreton Bay "Padymelon."  
 187 and 196. Right mandibular ramus of *Phalangista canina* (Opossum). [No. 187 sent to Queensland Museum.]  
 188 and 191. Left tibia of a "Padymelon." Unlike any existing species available for comparison.  
 189. Left side of pelvis of Rock Wallaby. Possibly *Petrogale penicillatu*.  
 190. Part of left mandibular ramus of a little Wallaby, smaller than any living species known to me. [Sent to Queensland Museum.]  
 192. Small bone, too delicate for manipulation.  
 193. Apparently the outer metatarsal of a Kangaroo Rat. (Compare 185.)  
 194. Part of skull of young "Padymelon." The nearest living species is *Halmaturus stigmaticus*, of the Cairns district.  
 195. Femur of young Kangaroo Rat, of larger size specifically (?) than No. 185.  
 197. Upper canine of a large Opossum, *Phalangista*, sp.  
 198. Right mandibular ramus of a Bandicoot. Very like, if not identical with, *Perameles nasuta*.  
 199. Second upper molar, off side of a Horse.\*

It may be remarked that my Colleague has determined four species of *Helix*, all living in the district, as occurring with the bones in the stalagmite deposit of Olsen's and Johannsen's Caves. The constant association of Recent land and freshwater mollusca with the remains of the extinct mammalia and birds in the drift beds has already been noticed.

From Cape Palmerston to the mouth of the Herbert River, the eastern coast is fringed by a strip of alluvial flat, varying in breadth up to thirty miles or more. Although apparently level to the eye, it attains an elevation of nearly three hundred feet at the base of the Coast Range west of Townsville. Whether seen on the spot, or as delineated on the Geological Map, the first idea of the observer is naturally that this alluvial flat is a Raised Beach; but, in spite of the presence of beds of clay well fitted to preserve fossils, no remains of marine organisms have ever, so far as I have been able to learn, been discovered in it.

Numerous bores and wells have proved this flat to be composed of alternating beds of clay, sands, and gravels, the latter being sometimes cemented or consolidated. The gravel, which is sometimes very coarse, contains well-rounded pebbles or boulders such as probably belonged to river beds. In the neighbourhood of Townsville, a bore (Bore A) at the Hubert Well did not "bottom" these drifts at 125 feet; a bore (Twaddle's No. 2) in Portion 100 (Stewart's Creek) had 101 feet of drift; and another in the same Portion (Twaddle's No. 4) had 109 feet of drift. As the sites of these bores are not more than thirty feet above the sea, the "rock-head," or old land surface, must be from eighty to one hundred feet below the present sea-level. No river could possibly have excavated a channel to this depth while the land stood at its present level. The land, therefore, must have been depressed to or beyond the position at which it now stands with reference to the ocean. Moreover, if, as I believe, the alluvia referred to are those of land valleys (lakes or rivers), their western walls or rim-rocks must have occupied sites now marked by islands in the Pacific or submerged or carried away by marine erosion. Fragments of this lost land remain, I believe, in Fitzroy Island, Hinchinbrook Island, the Palm Isles, Magnetic Island, Cape Cleveland, Feltham Cone, Cape Upstart, Gloucester Island, and the Whitsunday, Cumberland, Beverley, and Percy Islands; while a submerged range still further to the east may be represented by the Barrier Reef.

\* The occurrence of the remains of the Horse quite destroys the interest which would otherwise attach itself to this deposit from a geological point of view. (*R.E. Junr.*)

This submergence, in all probability, took place after the period to which the Extinct Mammalia belonged. It is probably the same submergence to which the late Rev. J. E. Tenison Woods attributed \* the formation of Sydney Harbour. I am quite in accord with Mr. Woods on this point, as the harbour has all the appearance of a submerged land valley.

The late Mr. C. S. Wilkinson ascribed † the depression which created Sydney Harbour to certain faults which divide the tableland of the Blue Mountains from the low-lying coast country, arguing that the faulting took place towards the close of the Tertiary Epoch, "for no marine Tertiary deposits are known along this portion of the coast of Australia, whereas in New Guinea on the north, and in Victoria on the south, the marine Miocene beds occur at elevations up to eight hundred feet above the sea. Had this low-lying country along the East coast of Australia then existed, it must have been covered by the Miocene sea, and doubtless some traces of the marine strata of that period would have escaped denudation and remained, as those have which are seen in Victoria and elsewhere; but it is very probable that until or during the Pliocene period it stood above the sea-level and extended some distance beyond the present coast line. Then, again, the Tertiary deposits throughout East Australia show that the valleys draining the Great Dividing Range have been chiefly eroded since the Miocene period, for we find deep valleys and ravines cutting through later Tertiary formations; therefore the sinking of the land traversed by any of these valleys—such as that of Port Jackson—evidently took place in comparatively recent geological times, and may have been contemporaneous with the extensive volcanic eruptions of the Upper Pliocene period during which the southern portion of Victoria especially was the *locale* of great volcanic activity."

I regret that I cannot agree with the reasoning of my lamented friend, so far as regards the age of the faults in question. All that is certain on this point is that the faulting took place at a period subsequent to the deposition of the strata which they disturb, as no strata of later date are superimposed on the faults themselves. There is no evidence that a low-lying country was immediately produced on the down-throw sides of the faults. The country east of the faults may have remained during Miocene times at a level high enough to be above the reach of the Miocene sea, and may have only since then been reduced by sub-aërial denudation to the present level. The argument from "deep valleys and ravines cutting through later Tertiary formations" fixes the oldest possible, but by no means the newest possible date for the depression of the land surface resulting in the formation of Port Jackson.

It need excite no surprise that the same Geologist who denied that the Desert Sandstone had been laid down at a lower level than that at which it is now found refused to admit that "one well-recorded observation has been brought forward" in proof of recent elevation on the Eastern coast.‡ Nevertheless, there are several observations on this point which must be treated with respect.

Near Cape York, Dr. Alexr. Rattray, Surgeon, R.N., noted§ several circumstances which prove that Raine Island has in Recent and even in modern times risen from its former position. He says:—

"Raine Island, which possesses its own special and active fringing reef, is low, flat, about one-third of a mile long, and a quarter of a mile broad. It rises about ten feet above

\* *Journ. R. Soc. N. S. Wales*, 1882-1883, xvi., p. 53. The Hawkesbury Sandstone.

† Notes on the Geology of New South Wales. 2nd. Edition, p. 70. Sydney: by Authority: 1887.

‡ Rev. J. E. Tenison Woods. Geology of Northern Queensland. *Trans. Queensland Philosophical Society*, 20th December, 1880.

§ Notes on the Geology of Cape York Peninsula. *Quart. Journ. Geol. Soc.*, xxv. (1869), p. 303.

high water, and consists of hard, compact, brecciated coral conglomerate, with a shelving beach of coarse coralline and shelly sand, and a scanty superstratum composed of the coral débris sparingly mixed with vegetable matter, and a thin layer of guano deposited by the numerous turtle and flocks of terns, gannets, and other aquatic birds that, like the former, make this their headquarters and favourite breeding-place. The whole constitutes a soil capable of supporting a scanty vegetation of weeds, coarse grass, and creepers, but sometimes—as at Cairncross, the Howicks, Pipers, and many others—a dense scrub and well-grown mangroves—*Casuarina*, *Pandani*, *Pasonia*—and other trees common along this coast. Of this organic rock the beacon on Raine Island was built eighteen or nineteen years ago; and the durability of the material is shown by the fact that the structure has hitherto undergone no decay from weathering. It doubtless tops some crystalline formation, on which it has been slowly reared. Still, it is evident that, though now permanently out of, it must have been formed while under water, and have reached the surface at low water with the zoophytes which built it in full activity, when the greater part of the long reef now in full activity at the sea-level at ebb, and of which it forms only a fractional part, was still many feet below. And now, when the latter has reached close to the surface at low water, the former projects twenty feet in the air, but denuded by weathering of its soft and brittle exterior, with its dense solid interior laid bare, and its living, many-hued, branching madrepores replaced by less gaudy forms of vegetable life.

“Between the active coral reef still under water and the extinct ones now well raised above it, like Raine Island, we meet with many intermediate forms, occasionally as islets which consist of a sand-bank just showing above the surface, and either still unclad with vegetation or having a few sprouts of mangrove, the hardiest of trees, and usually the first to find a footing in the coarse coral débris, little capable, to all appearances, of sustaining life of any sort, while others show greater elevation, and both more extensive and better-clad area. In short, we find islands of this class in many different stages of upward progress, sometimes forming part of the reef, but more usually lying between it and the mainland.”

The late Professor J. B. Jukes mentioned\* the occurrence of pumice pebbles on a plain on the west side of Lizard Island, “at least one or two hundred yards back from the sea, and several feet above any possible tide.”

A Raised Beach extends for five miles north of Camisade Creek, Temple Bay. It is ten or twelve feet above high-water mark, is nearly a quarter of a mile in breadth, and is covered in places with blown sand. I have reason to remember this locality, where I was speared through the neck in the course of a murderous attack by the blacks, who filled up the tents of the party with spears.†

Mr. G. Elphinstone Dalrymple, in his Narrative of the Queensland North-east Coast Expedition, 1873, (p. 16,)‡ refers to a “high beach of broken coral, shells, and granite detritus,” on the north-west side of Fitzroy Island, and adds:—“Here there is a recurrence of the old raised beaches and pumice pebbles rising in successive steps from the sea-level.”

Mr. W. Saville Kent, F.L.S., in a Presidential Address to the Royal Society of Queensland (22nd November, 1890),§ has the following:—

“Apart from the vital processes by which reefs and their component corals are continually adding to their bulk, there can be but little doubt that a slow motion of

\* Narrative of the Surveying Voyage of H.M.S. “Fly,” i, p. 95. London, 1847.

† Report by R.L.J. on Explorations in Cape York Peninsula, 1879-80. Brisbane: by Authority: 1881, p. 41.

‡ Brisbane: by Authority: 1874.

§ Proc. Ann. Meeting Roy. Soc. Queensland. Brisbane, 1891, p. 38.

upheaval is progressing throughout the region of Torres Straits and the Great Barrier system, and this, too, must tend towards rendering the older charts untrustworthy. The coral reefs volunteer their own evidence upon this point. At many stations throughout this region the circumstances may be noted that large expanses of dead coral intervene between high water mark and the living banks. This dead coral here referred to, is not the broken *débris* that has been cast up by storms, such as commonly exists all along extreme high water mark; but occurs at a lower level *in situ* as it originally grew, and is only lacking in vitality to distinguish it from the living reefs. The Albany pass between Cape York and Albany Island, yields a prominent illustration of this phenomenon. On either side of the passage there is a fringing coral reef, the living inner margin of which, composed chiefly of a branching Madrepore, is only exposed at the lowest spring tides. Immediately adjoining this living bank, between it and the foreshore, there is a belt of the same species of coral, but entirely dead and brittle, like rotten ice to walk upon. Within a few more years this dead belt will no doubt be broken up by the action of the waves and chemical disintegration, and be added to the existing inshore area of coral mud and *débris*. An examination of the circumstances that have brought about the present condition of the reef shows that this dead belt of coral is now exposed to atmospheric influences, which are antagonistic to its growth, with every ordinary spring tide; while the living coral, as before observed, is only visible above the water at the exceptional or lowest springs. At the period that the inner belt of dead madrepore was alive, and which from its state of preservation cannot be long ago, it must have grown at a similar lower level as that now living, and nothing but the general upheaval of the area on which it thrives can logically explain the fact of its decadence. The fringing reef off Magnetic Island, near Townsville, presents closely analogous phenomena. Dead bivalve shells of large size, such as *Tridacna* and *Pinnas*, also occupy their original positions here, in close contiguity to the dead corals. Yet more substantial evidence of the upheaval in this district was afforded me by a station-holder on Magnetic Island, and by whom I was informed that within the time he had been located there a very perceptible change had taken place in the small bay facing his property. In former years boats could approach the landing-place at all tides, excepting very low springs, whereas now it was not possible to bring a boat in at even ordinary low tide. The shallowing of the water could not be accounted for by the silting up of the bay, there being no fresh water flowing into it, while the rocky bed of the bay itself had apparently been raised to a higher level. The instances now recorded might easily be multiplied."

Mr. Maitland describes \* the occurrence of stranded pumice in various parts of Magnetic Island, notably on those portions most exposed to the open sea, and adds that he never observed it at a greater elevation than twelve feet above sea level. "The rounded form and somewhat decayed interior presented by many of the pebbles, bear evidence of their having travelled some considerable distance, and as has been noticed by various observers in many islands of the Pacific, pieces were found incrustated with calcareous tubes of the tubicular annelids, *Serpula* and *Spirorbis*. The source of these pumice drifts is to be looked for in many of the volcanic islands with which the Pacific is known to be studded."

I am informed by Mr. Joseph Hughes, Sub-collector of Customs, Townsville, that on Rattlesnake Island a deposit of dead coral, similar to that described by Mr. Saville Kent, occurs at about five feet above high water mark.

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\* Report on Magnetic Island. Brisbane: by Authority: 1892.

In Ross Island, Townsville, near the mouth of the Ross River, a thick bed of clay forms part of an estuarine deposit above high water mark. This is a "Raised Beach," in the ordinary sense of the term. It is crowded with fossil shells, and the late Professor Denton having insisted that it was of Tertiary age, I made a collection, which my Colleague examined and found to consist entirely of species still living in the adjoining seas.

The late Prof. Jukes, speaking of the coast flats near Cape Upstart,\* referred to pebbles of pumice found among the grass and under the roots of the trees "wherever we landed, from Sandy Cape to this place," and added, "I have never observed them at a greater height above the sea than fifteen feet." I can confirm Prof. Jukes' remarks and extend them to almost every part of the Eastern Coast I have visited.

Speaking of the coral conglomerate of Cape Upstart and the Capricorn Islands, Prof. Jukes remarked †:—

"Flats composed of it, half-a-mile in width, are frequent along the shore of the north-east coast of Australia. Upon all these flat spaces formed of the conglomerate, as well as upon all other flat land along the eastern and north-eastern coast of Australia, which is not more than ten feet above high water mark, there is found an abundance of pumice pebbles. They are never, or very rarely, seen on the present beach or recently washed up, nor are they found now floating at sea. . . . They are also found embedded in the coral rock of Raine's Islet. Whatever age, therefore, may be given to the coral conglomerates must be extended to the pebbles."

In the neighbourhood of Nudgee, near the mouth of the Brisbane River, a sandy Raised Beach, perhaps twenty feet above sea level, contains an abundance of fossil shells all of living Pacific species—at least no other have been detected in a collection made by me and critically examined by my Colleague.

Speaking of Peel Island, Moreton Bay, Mr. Stutchbury wrote ‡ in 1854:—

"In proof of its modern but gradual uprising, I offer the following facts:—  
"The whole length of the beach on the eastern side, above the present water line, is studded with dead coral *in situ naturale*, much of it never having been removed from the place in which it lived, principally consisting of the genera *Meandrina*, *Astrea*, and other shallow water corals. It is known that these genera, although capable of living in very shallow water, cannot exist the length of an ebb tide unless there is a spray sea wetting them, and, as it does occur that at occasional times, during changes of wind or calm, they would be left perfectly dry for six or seven hours, then, from the delicate nature of their structure they would be destroyed, and such is the case here exhibited. In addition, I find that in the shallow waters—now mere sandbanks (which may be waded at a depth of three or four feet) of areas of hundreds of acres—there may be seen *Pocillopora*, *Caryophyllaea*, and other genera which only exist in tolerably deep water, *i.e.*, from five to ten fathoms. No living species of the latter genera are now to be found in the bay. I endeavoured to obtain them by the dredge, but without success, but on the shallow banks, always covered even at low-water, fine examples of the first-named genera may still be found alive. Further, several feet above the present high-water line, clumps of dead rock-oysters may still be seen adhering to the rocks on which they grew.

"The above facts, taken together with those seen in the islands of the River Hunter, described in the Report of my trip to Newcastle and Maitland in December, 1850, I think are sufficient to prove that the whole of this vast island [Australia] is still gradually emerging from the ocean."

\* Narrative of the Surveying Voyage of H.M.S. "Fly," i., p. 53. London, 1847.

† *Loc. cit.* p. 335.

‡ Twelfth Tri-monthly Report upon the Geological and Mineralogical Survey of New South Wales. *Legislative Assembly Paper, N.S. Wales*, p. 7.

In his next (Thirteenth) Report Mr. Stutchbury gave further proofs of the modern uprising of the land in Moreton Bay District, under date 20th May, 1854:—

"At Luggage Point\* I found the remains of a skeleton of an exceeding large whale which had been thrown whole upon the beach. It was much decomposed, every cell in the bones being filled with mud, and deposited just within the verge of the present high water mark, in fact in such a position that it would have been impossible for the highest waves to have rolled it from deep water over the extensive shoals which lie out in this direction."

On Bribie Island "the whole of the eastern seaward coast is composed of the purest sand, with scarcely a pebble intermixed—an east and west section showing, in a line of a quarter of a mile in length, several distinct parallels of shore—a further instance of the fact of upheaval."

In his "Sixteenth Report," dated 20th November, 1855, Mr. Stutchbury has the following note on Fraser Island:—

"The curvilinear beach between South Trees Point and Barney Point presents an immense barrier of marine shells, extending far above the present high tide limit, and a few yards further inland considerable quantities of detrital pumice may be observed. This occurrence of pumice above the tidal lines of this period presents itself along the whole of the north-eastern shores, especially on the eastern or ocean beach of the Great Sandy Island."

Mr. Alexander Macpherson read a Paper before the Royal Society of Queensland, on 7th August, 1890, showing from observations at Sandgate and Nudgee that the land at the mouth of the Brisbane River is gradually being elevated.

As shown in an exhaustive Memoir by Mr. T. W. Edgeworth David and my Colleague,† raised beaches occur in the delta of the Hunter River, New South Wales, and reach to fifty feet above the sea level.

I hold that a great submergence of the eastern coast (as exemplified by Sydney Harbour and the Townsville Deep Drifts) was, at a comparatively recent date, succeeded by a movement of elevation, which is still in progress.

No evidence of a Post-Tertiary Glacial Period has ever, so far as I am aware, been met with in Queensland, unless the presence of temperate plants on some of our tropical mountains be taken to afford the necessary proof. It is not improbable, however, that evidence may yet be found in the southern ranges of the Colony of an approach to the climatic conditions which prevailed in South Australia and perhaps in Victoria and the southern parts of New South Wales (Mount Kosciusco).

Professor Ralph Tate, in a Paper read before the Australian Association for the Advancement of Science at its meeting in Sydney in 1888,‡ described certain glaciated surfaces on the shores of Hallett's Cove, in St. Vincent Gulf, a few miles from Adelaide, in the following terms:—

"The glaciated surface, which I announced in 1877 as well developed on the coast cliffs at Hallett's Cove, south of Holdfast Bay in St. Vincent Gulf, remains as yet unique; but once it is accepted as of glacial origin, many other features obscure in themselves acquire co-ordinate value in relation therewith. It is not my purpose to describe the various signs which now can safely be attributed to glacial action, but simply to bring to your notice tangible evidences of the glaciated condition of the rock surface at Hallett's Cove, and of its associated moraine *débris*. Actual inspection would, I am sure, convince you.

\* The north head of the mouth of Brisbane River.

† Rec. Geol. Survey of N. S. Wales, 1890, ii., 2.

\* Proc. Austr. Assoc. Adv. Sci., 1890, i., p. 231

"The path of the glacier is traceable for a distance of two miles along the top of the scarped sea-cliffs at about forty feet above the sea-level; on the north it is cut out from the cliff by encroachment of the sea; from this point the glaciated surface is continuous in a southerly direction for a distance of one mile to Black Point, the north headland of Hallett's Cove. On the line of the glacier there now intervenes the broad but shallow bay of Hallett's Cove, but on the south headland the track is picked up on about the same trend, though apparently at a little higher level—here again the glacier path is soon cut out by removal of the cliff.

"On the north side of the Cove the glaciated surface is beautifully displayed, the edges of nearly vertical strata are sheared off, and when of quartzite the surface shows a high polish, and when of mudstones conspicuous grooves and striæ. Some moraine *débris*, including stones that have been beneath the glacier, occur here. On the south side moraine matter is very abundant, and includes many boulders, some occurring as *blocs perchés*.

"The common rocks of the morainic *débris* are granites, gneiss, hornblende-schists, and others, which do not occur *in situ* nearer than the gorge at Normanville, about forty-six miles to the south. In all seventeen distinct varieties of rock, chiefly metamorphic, and foreign to the immediate neighbourhood, have been collected along the path of the glacier.

"The proximity of the Miocene escarpment suggests the possibility of the Pre-Miocene age of the glacier. The Miocene formation throughout its whole length on this part of the coast has a conglomerate base consisting of well-rounded pebbles of limestone and quartzite and flat pebbles of slaty rock, but none other than local material has been yet observed, though diligently searched for. It is highly probable that the glacier cut its way through the incoherent Miocene formation, and that some of the Miocene shingle furnished some portion of the moraine *débris*.

"Some measure of the antiquity of the glacier is further afforded by the amount of marine erosion that has subsequently taken place. Assuming that the glacier was in an alignment with the two headlands of Hallett's Cove, then a length of three-fourths of a mile by a breadth of one and a-half furlongs, and a thickness of forty feet, has been removed since the glacier ceased to exist."

The correctness of Professor Tate's observations has been called in question by Mr. Gavin Scoullar,\* Professor Hutton,† Dr. Lindenfeld,‡ and others, but the two latter gentlemen, at least, have not seen the place.

An opportunity having occurred, I visited the locality, in company with Professor Tate, in March, 1891. As it was my almost daily occupation for at least ten years, when engaged on the Geological Survey of Scotland, to map the direction of glacial striæ, I may, without vanity, lay claim to some knowledge of the subject. I came to the conclusion that Professor's Tate's observation was correct in every particular, and, in addition, satisfied myself that the movement of the ice must have been from south to north. There are certain little niceties of observation which enable one to judge of the direction of the movement of an ice-sheet when producing polished surfaces and striations. Thus, for instance, in passing over a slight fissure, the sharp edge of the solid angle formed by the planes of the surface and of the side of the fissure will be polished on the side furthest away from the motive force, while the edge on the other side of the fissure will not be interfered with. Professor Tate has never committed himself to an opinion on this point, although he expressed himself as satisfied with the

\* Proc. Roy. Soc. South Australia, 1884-5, p. 46.

† Quart. Journ. Geol. Soc., xli., p. 213.

‡ Proc. Linn. Soc. N. S. Wales, x., p. 2.

evidence which I pointed out when on the spot. A movement from south to north accords very well with Professor Tate's own observation that "the common rocks of the morainic *débris* are granites, gneiss, hornblende-schists, and others, which do not occur *in situ* nearer than the gorge at Normanville, about forty-six miles to the south."

Naturally, it seemed reasonable to suppose that a local glacier must have produced the *roches moutonnées* and *striæ*, but, on the other hand, there are no mountains in the neighbourhood of sufficient altitude to give rise to a glacier of such importance as to fill the whole broad valley occupied by St. Vincent Gulf. It is equally true that there is no sufficiently high land to the south. It is possible, but not probable, that such high land may have formerly existed either to the north or south, and have subsequently been depressed. Violent as the supposition may be, it is more likely that an Antarctic ice-cap extended as far as the southern coast of Australia. South of St. Vincent Gulf, and west of Tasmania, an oceanic depth of over twelve thousand feet is speedily reached, and in sea-water of this depth ice of nearly seventeen thousand feet in thickness would float without grounding. These figures may be supposed to reduce the argument in favour of an Antarctic ice-cap *ad absurdum*. Be this as it may, I regard it as an ascertained fact that a sheet of ice moved from south to north up St. Vincent Gulf.

As bearing on the question of the possible extension of an Antarctic polar ice-cap, some pregnant observations were made during the Scientific Voyage of the "Challenger." Not having it in my power to refer, as I write, to the "Challenger" reports, I am compelled to quote, at second-hand, from some comments thereon by Mr. G. S. Griffiths, F.G.S.,\* relating to evidences of a Glacial Period from Kerguelen Land.

Kerguelen Land is situated in the Indian Ocean, approximately in Long. 70° E., and Lat. 50° S.—i.e., about 15° south of the latitude of Adelaide. It may be remarked, further, that it is just south of Kerguelen Land that the curve denoting the northern limit of (Antarctic) drift ice recedes nearer the pole than in any other portion of the Southern Hemisphere. The curve is denoted on physical maps as keeping about 10° or 12° south of the Australian Continent, and about the same distance south of Kerguelen Land, although the latter is quite 15° further south than the former. For a continental ice-cap to reach Australia from the southern polar regions would be no more remarkable, therefore, than for one to reach Kerguelen Land. In other words, the change of temperature required to bring about the one would suffice to bring about the other. That the evidence of a Glacial Epoch in both places is much of the same character will be evident from the following extract:—

"The interesting feature in relation to these glaciers is that, whereas they are to-day confined to the higher valleys of the higher ranges, there are abundant and indisputable evidences that the whole island down to and even below the sea-level was buried under ice at a comparatively recent period. The furrows of glaciers are seen wherever the island has been explored. The lower hill-tops, still bare and barren, have been cut down by travelling ice, which has planed them smooth, exposing clean-cut horizontal sections of the geodes of the amygdaloidal rocks. Each shelf of the basalt stairs has its *striæ*, and the lower valleys are scratched and scraped and smoothed by glaciers which have since disappeared. Every harbour is an ice-cut fiord.†" It may be remarked that the whole island being buried under ice is apparently inconsistent with the idea of local glaciers.

\* Trans. R. Soc. Victoria, xxiii.

† "Challenger" Reports, p. 356.



If an Antarctic ice-sheet actually impinged upon the shores of the Great Australian Bight, we may expect to hear of the discovery in Victoria of glaciated surfaces similar to those of St. Vincent Gulf, although, perhaps, the soft and incoherent Tertiary rocks of which a great part of the southern coast-line is composed may be unfavourable material for the retention of markings.

The evidences of former glacial action are thus succinctly summed up by Mr. James Stirling, F.G.S., F.L.S.\*:—

“Erratics in the Mitta Mitta and the Kiewe Valleys, huge blocks weighing many tons; smoothed surfaces on the Cobberas Mountains and Mount Bogong; morainics at the base of the latter on the Mountain Creek Valley; eroded lake basins, Dry Hill, Hermomugee Swamp; Omeo lake basin; morainic lake, Mount Wellington; smoothed and scratched surfaces on Mount Kosciusko. The interest appertaining to this question is no doubt great, and although the fact of glacier action can, I think, be satisfactorily established in the Australian Alps, yet further evidence is desirable as to the synchronism of the glacier period in Australia with that of the glacial epoch in the Northern Hemisphere. That the glacier action was widespread over South-east Australia, I have no doubt, and without entering into a discussion as to the causes of such glacier action, it seems to me difficult to resist the conviction that, considering the uniformity of natural operations all over the globe during past time, Australia was not exempt from the refrigeration which in the Northern Hemisphere culminated in a glacial epoch. The geological evidences are, I think, accumulating in favour of the view that glacier action has played a very important part during Mesozoic and Palæozoic time in the distribution of boulder deposits and the abrasion of rock surfaces. Mr. Dunn, F.G.S., has recently found some well-marked striated boulders in the Older Tertiary conglomerates in the Beechworth district, which may be seen at the Melbourne Centennial Exhibition, while the author has found similarly striated boulders in the Upper Silurian conglomerates of the Gibbo River.”

To the most recent phase of the Post-Tertiary, and extending to the present day, belong the accumulations of Blown Sand, or Dunes, which fringe the coast at intervals from Cape Moreton to Cape York. In some cases the Blown Sand attains a considerable elevation, but this circumstance must be attributed to such conditions as force and direction of the wind, slope of the land, &c., and not to upheaval.

Blown Sand occurs at the north end of Moreton Heads, and all along the western or sheltered side of Moreton Island, at a height of about 150 feet above the sea.

At Double Island Point, near the south end of Fraser Island, the late Rev. J. E. Tenison Woods referred† to “a formation of sand which forms cliffs for some three or four miles,” and adds that the sand cliffs “are densely covered with a light brush (*Melaleuca genistifolia*?). The cliffs of sand are quite precipitous on the seaward side, and are from 100 to 200 feet high. On a close examination, the cliffs present exactly the appearance of the Hawkesbury Sandstone, except in colour, and they are not consolidated.‡ There are the same undulating ‘layers,’ of varying thickness, forming thick sinuous marks upon the cliffs, which can be seen at a great distance. The layers are entirely constructed of laminæ of sand, with false bedding, which dips at every angle not outside 30°. The layers are of different colour, and they seem to preserve this colour throughout, giving the cliffs a curious ribbon-like structure. Some are white,

\* The Physiography of the Australian Alps. Proc. Austr. Assoc. Adv. Sci., i., 1889, p. 359.

† The Hawkesbury Sandstone. Journ. Roy. Soc. N. S. Wales for 1882 (1883), xvi., p. 53.

‡ The Author argued that the Hawkesbury Sandstone is of æolian origin, and mentioned the sand-dunes of Double Island Point in illustration of the theory, which is inconsistent with the fact of the discovery of fish-remains in the Hawkesbury Sandstone, and with many other observed facts.

others yellow, and some ochreous red. The formation is entirely one of blown sand. On the surface, where ti-tree brush does not grow, the sand forms the usual shifting dunes of rounded outline and great height. In places there are sand-slips on some of the dunes, where the false bedding becomes revealed. The undulating lines which separate the various layers are found to consist of decaying vegetable matter, or rich loamy earth with roots, leaves, and land shells intermingled. They represent the former surface of the drifting sand, where its shifting has been stayed by the growth of a dense brush. Thus it has remained stationary for years, until a change of wind, or, perhaps, a bush fire, has brought the sand on to the surface again and overwhelmed it. In part of the brush there are swamps of water; at least, so I was informed. . . ."

Sand-dunes occur near Mackay, between East Point and Armhurst, "forming hillocks of no very great height and of which the landward slope is much steeper than that facing the sea."\*

North of Townsville, in the Town Common, and south of Townsville, between the mouths of the Ross River and Alligator Creek, the Raised Beach is covered in places by three or four parallel ridges of blown sand which sometimes attain a height of thirty feet.

In Shelburne Bay, Cape York Peninsula, sandhills occur at a considerable elevation, and enclose a circular lagoon of fresh water about a quarter of a mile in diameter.†

In Temple Bay, the Raised Beach already referred to as occurring north of Camisade Creek is partly covered by blown sand, which extends for a considerable distance inland and attains an elevation of nearly four hundred feet.‡

Sandhills stretch inland for a considerable distance from Orford Bay, attaining a height of three hundred feet in places.‡

#### HAS MAN A GEOLOGICAL HISTORY IN QUEENSLAND?

The answer to this question may be given in one word—No. That is to say, so far as I am aware, no evidence of the presence of Man, or of his works, has yet been discovered in any raised beach, cave, or stratified deposit associated with the remains of extinct animals.

The question "Has Man a Geological History in Australia?" has been discussed at length by my Colleague in the Proceedings of the Linnean Society of New South Wales.§ His conclusion is as follows:—

"(1) Up to the present, as at the time Mr. R. B. Smyth wrote, the existence of Man's works in any geological deposit, above question, has not been shown to exist. (2) The molar crown found in the Wellington Breccia Cave appears to be that of a human being, and is to all intents and purposes a fossil. (3) Its position in the cave and association with the other organic remains there entombed is open to doubt. (4) No other human remains have been found at Wellington under similar conditions.

"The mineralized condition of the tooth is, of course, its strongest recommendation; but I do not think that, in a momentous question of this kind, and one on which so much theory can be built up, this should be allowed to outweigh other evidence pointing in a different direction.

"The matter can hardly be summed up better than by the very reasonable and often correctly applied Scotch verdict of 'Not proven.'

\* Report on the Geological Features and Mineral Resources of the Mackay District, by A. Gibb Maitland. Brisbane: by Authority: 1889.

† Report by R.L.J. on Explorations in the Cape York Peninsula, 1879-80. Brisbane: by Authority: 1881.

‡ *Ibid.*, p. 41.

§ 1890, v., (2), p. 259.

"In conclusion, I would distinctly wish it to be understood that I have not lost sight of the bearing the relative antiquity of the Tasmanian Aborigines has on this subject. The former geological connection of Australia and Tasmania now appears to be a generally accepted fact. The late Mr. James Bonwick regarded\* the Tasmanians as an older race than the Australians, although emanating from a common centre, and dispersed over a then existing continent of which our present Australia and Tasmania formed portions. If such be the case, how vast a period of time must have elapsed since then, allowing for the formation of the channel we now know as Bass Straits; and herein lies one of the strongest proofs of Man's early existence on the Island Continent of Australia. Notwithstanding this, however, there remains the undoubted fact that we still lack trustworthy geological information of the approximate date of his first advent in Australia."

Professor Ralph Tate, on the other hand, would assign to Man in Australia an age as far back as Pliocene. Speaking of the volcanic district of the south-eastern portion of South Australia (Mount Gambier, &c.), he says †:—

"The Pliocene sands and loess of this place are of terrestrial origin; they contain remains of *Diprotodon*, *Phascolomys pliocenius*, McCoy; and leaves of *Casuarina* and *Banksia* are imprinted on the under surfaces of the superimposed ash layer.

"Did Man witness the showers of ashes and the glow of the internal fires of these cones reflected from the clouds? Probably, Yes! . . . The dingo (*Canis dingo*) was the contemporary of the *Diprotodon*, whose remains are buried beneath the ashes of the Mount Gambier volcano, as proved by their remains occurring together in the Gisborne and Wellington Caves.

"Now, the dingo is an alien; he forms no part of the Australian fauna; and his introduction by Man, as a companion and assistant in the chase, can only satisfactorily explain his presence in this continent. Man and dog may have pursued together the *Diprotodon*, and in later times have been awed by the volcanic outbursts. Indeed, no other cause of extirpation of the huge mammals has suggested itself to the mind of Professor Owen, save that of human agency. He says, 'To a race of men, depending, like the blackfellows, for subsistence on the chase, the largest and most conspicuous kinds of wild beasts first fall a prey.'"

I am quite willing to admit that the Dingo is an "alien"; but it is open to question whether the agency of Man was the only possible means of effecting his introduction into this island. The Dingo is a wily animal, full of resource and self-reliance, and very different in this respect from the domesticated dog, which appears to have to some extent lost the habit of independent action, as it is well known that many dogs will suffer agonies of thirst rather than go to the nearest water, unless their masters take them out "for a walk." The Dingo, as we know him to-day, is capable of taking care of himself, and he or his ancestors may have arrived in Australia by some chance means of conveyance without assistance, or may have simply walked overland. It is quite possible, therefore, that he may have been contemporary with the *Diprotodon*, and have witnessed the ash showers of Mount Gambier without having had his emotions shared by a human companion. ‡

\* J. Bonwick. *Daily Life and Origin of the Tasmanians*, 1870, p. 259.

† Anniversary Address to the Royal Society of South Australia, for 1878-9.

‡ There is not a fragment of evidence to show that the arrival of Man was coeval with that of the Dingo. On the contrary, the absence of authenticated remains of the former with those of either the *Diprotodon* or Dingo points rather the other way. It is not even certain that the bones of the Dingo have been found in the Wellington Caves. On the other hand, the late R. Brough Smyth states that the remains of the Dingo have been found under "volcanic ash some thirty or forty feet in thickness." If my memory does not deceive me this was at Towerhill, Warrnambool. (*R.E. Junr.*)

## THERMAL AND OTHER SPRINGS.

It is desirable to record in this place such information as we have on the subject of the Thermal and other Springs which break out, chiefly, in the Western Interior. The subject is closely connected with Artesian Wells, as has been remarked in a previous chapter.

Further notes on the springs which break out at the base of the Desert Sandstone will be found in Chapter xxxiii. (p. 513).

*Mud Springs, Hamilton River.*—Mud springs break out in many places between the channels of the Hamilton River (Lat.  $23^{\circ} 20'$  S., Long.  $140^{\circ}$  E.). These are described by a writer in the *Townsville Bulletin*\* as “miniature volcanoes casting out liquid mud instead of lava.” In several bores in this neighbourhood Artesian Water has been met with at shallow depths.

*Hot Mud Springs, Flinders River.*—Daintree, in his “Notes on the Geology of Queensland,”† described as follows the hot spring on the Saxby River:—

“At Gibson’s Cattle station, on the Saxby River, a tributary of the Flinders, a spring of hot water rises above the surface of the plain; and its overflow deposits a white incrustation, which, on analysis by Dr. Flight, under the direction of Professor Maskelyne, afforded:—

Water	...	...	...	...	...	...	...	...	27.793
Silica	...	...	...	...	...	...	...	...	0.600
Chlorine	...	...	...	...	...	...	...	...	3.369
Sodium	...	...	...	...	...	...	...	...	2.183
Carbonic acid	...	..	...	...	...	...	...	...	33.735
Soda	...	...	...	...	...	...	...	...	31.690

99.370

“The sulphuric acid, of which there was a small portion, was undetermined.

“Apart, therefore, from the 5.552 per cent. of chloride of sodium, the deposit consists of sesquicarbonate of soda, or native Trona, and as such it is used by the settlers for culinary purposes, &c.”

I do not gather from Daintree’s Paper that he had seen the hot spring referred to; at least he gives no description. This is supplied by Mr. E. Palmer, M.L.A., in a Paper on “Hot Springs and Mud Eruptions on the Lower Flinders River.”‡

Mr. Palmer remarks that the Springs “on the Lower Flinders occur in separate clusters, each consisting of innumerable small eruptions, surrounding one or two large central or main springs, within a radius of a mile or so, and all more or less in a state of activity—that is, they emit streams of thin mud or water intermittently. They are found on either side of the river, and seem to have no connection with, or influence on the water in the river, which may be said to be only a surface water. Although possessing a striking similarity to each other, still any connection between them must exist beneath the present course of the Flinders, which is cut out of the level plains by the annual tropical rains, and is a river of Recent times; no hollow or valley exists where the course of the river runs; the banks are nearly perpendicular, but not very deep, while the level plains extend right up to the bank of the river. The springs belong to an older formation than present river system, and must derive their force from some very distant inland mountainous country.”

\* 23rd July, 1891.

† Quart. Journ. Geol. Soc., xxviii. (1872), p. 28.

‡ Proc. Roy. Soc. Queensland, i., 1884 [1885], p. 19.

After describing the course of the Flinders, Mr. Palmer continues:—

"The only elevations are Mount Browne, in about 20° south latitude, a low stony rise of ironstone and granite, rising from the plain, and about a mile from the river on the right side, and Fort Bowen, twenty miles west, similarly situated with regard to the river, and rising also abruptly from the open plains. These are the only rises of any consequence near the river, and at both of these small mountains numbers of springs and mounds of erupted mud, coated with a whitish crust of soda, lie scattered about, with stumps of large tea-tree and reeds, and pools of discoloured water throughout; while at Mount Browne occur two hot springs on the south side with a temperature of 120° Fahrenheit at the surface. The water stands in a large basin on a mound raised many feet above the level of the plain, and covered with gigantic tea-trees (*Melaleuca leucadendron*), amongst the matted roots of which the hot water streams in clear, shining, crystal pools. The basin, or cavity, is fathomless, while the roots and branches lying in it are coated with a soft, green vegetable matter with air-bubbles attached, small bubbles of carbonic acid innumerable, which are continually rising to the surface. The water is too hot to bear the hand in for any length of time; but when cooled is good for use, and always bright and clear and free from any taste, while that in the adjoining cold springs is extremely disagreeable. No change has been observed in the hot springs in level or temperature since 1865, when a cattle station was settled there by Mr. James Gibson.\* The ground round all these springs is treacherous, is hollow, shakes to the tread, and feels like a huge blister, merely covered with a skin of soil, held together by roots and rushes, over which one can walk. At times the pressure from below forces the thin crust upwards, and a flow of this brown liquid mud spreads about, sometimes in great quantities. In one of the springs at Mount Browne, flakes of granite are forced up and lie on the surface. It seems as if a connection existed down by the side of the mountain to subterranean regions, whence the hot water flows, and is kept at one constant level and temperature. Most of the mud springs have formed large mounds, or cones, by constant overflow, and the water now stands at the top, while the surrounding parts are spongy, and liable to break through when stock comes near them; at others lagoons are formed, and kept at a uniform level by the flow of water. The occurrence of these hot and cold mineral springs suggests the possibility of obtaining supplies of water on the artesian principle over some portion at least of these extensive plains. Some mud springs, as they are called, opened at Manfred by a small shaft at the side, produced a permanent flow of good water.

"Fresh ground keeps continually breaking up, or is forced up, while old cones are sometimes falling in, forming hollows half-full of reddish water, strong as lye, and quite undrinkable. None of the springs are isolated, but confined to the vicinity of one or other of the half-dozen groups which compose the collection on the Lower Flinders. The direction of these groups is in a north and south course from each other, with the Flinders River dividing them, and they are comprised within a line or distance of eighty miles. Above Dalgona Station, on Julia Creek, some very extensive mounds are an indication of the force of the pressure from below, while an open spring between it and the Flinders has numerous small fish in it. A thoroughly scientific description of these numerous and wonderful displays of natural forces would prove very interesting and instructive. The vegetation surrounding them is peculiar, and somewhat distinct from that of the plains. The locality of any of the groups of mineral springs is indicated by the presence of gigantic ti-trees surrounding them, and many

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\* I think there can be no doubt that this refers to the same Spring as that referred to by Mr. Daintree. (*R.L.J.*)

of the mounds present a pleasing green appearance, from being covered with a sward of *Fimbristylis*, in such masses, fallen or recumbent, as to form a safe carpet, yielding and soft, but dense enough to support cattle going in to feed on the various grasses found there.

"In ancient days the same springs have proved a trap for too-confiding animals, as is proved by the fact of some bones having been ejected in the mud from one of them; the bones are coloured, but in a good state of preservation."

On the Gilliat River, a tributary of the Cloncurry, below the junction of Eastern Creek, some mud springs are marked on the "Sixteen-mile Colony Map," but I have neither seen nor been able to obtain any description of them.

*Einasleigh Hot Springs.*—I visited these Springs in November, 1889, in company with Mr. A. Gibb Maitland.

The Springs have been known for about eighteen years, but the knowledge was for a long time confined to the station hands. Of late years, however, a few pleasure parties have gone out to visit them from Georgetown, the centre of the Etheridge Gold Field, from which they are distant about forty-five miles, and, since the opening of Croydon Gold Field, in 1886, a few rheumatic and other invalids have camped on the Einasleigh and bathed in the hot water. Mr. C. A. Vogan read a Paper on the Springs in September, 1888, before the Geographical Society in Sydney.

The Springs are best reached by following the river down from Cobb and Co.'s Stage on the coach road at the crossing of the Einasleigh. As the left bank of the river is flanked by rough broken country for some distance, it is best to keep the right bank for three miles and then cross to the left bank. The crossing presents no difficulty, as although the river is here nearly a hundred miles from its source and almost half-a-mile wide, its bed is, in ordinary seasons, a sandy waste, only relieved by occasional waterholes.

About six miles below the road the traveller is guided to the Springs by a small cloud of vapour rising from a mound partly concealed by trees in the middle of an alluvial flat, and distant about a quarter of a mile from the left bank of the river.

On closer inspection the mound proves to be a dome-shaped mass fifteen feet in height and two hundred yards in circumference, rising out of a plain of recent alluvial deposits. That the latter are of no great thickness is shown by sections on the river banks and in gullies, which expose gneiss, granite, and schists very near the surface of the plains.

Scattered over the dome are five distinct springs of clear, blue water, all of which, with one exception, leak quietly over their rims without ebullition or geyser action.

The story runs that about nineteen years ago the Georgetown Mailman heard, from a distance of two or three miles from the Springs, an explosion and a hissing noise like that of escaping steam. Little notice was taken of this report at the time, but a year later the Springs were found in the locality indicated by the mailman. If the story is true, it would appear that the Springs really do burst into geyser activity at rare intervals.

The apex of the mound is occupied by a sheet of water which measures roughly five by three feet across the mouth of a well which has a depth of six feet (Spring *a*). This Spring discharges by one principal and two minor breaks in the lip of the cup, streams having an estimated total section of nine square inches. Bubbles of gas continually rise to the surface, but at intervals of two and a-half minutes there is a rush of bubbles.

Eighteen feet north of (*a*), a pipe (*b*) of one foot in diameter is filled with seven feet of water, which does not rise to the surface of the mound nor discharge by any visible orifice. From the surface of the mound to the surface of the water is two feet,

and the cup is continued from the water-level upward, in funnel shape, the funnel measuring about three feet across the top. The surface is about five feet below the level of the apex of the mound. Gas-bubbles rise slowly through the water.

Fifteen feet north of (b) is a third well (Spring c), measuring six by four feet across the top, which is about the same level as that of Well (b). The water is three and a-half feet deep, and stands about six inches below the lip, but discharges to the north a stream, estimated at thirty-six square inches, two feet below the level of the lip. Gas-bubbles rise slowly through the water.

Twenty feet east of (a), a fourth well (Spring d) is three feet in diameter at the surface, which is on the same level as (b) and (c). The water, which is seven feet deep, escapes at the surface in a stream estimated at nine square inches, and at the base of the mound—i.e., ten feet below the surface level of the water—in a stream estimated at a hundred and forty-four square inches. Gas-bubbles rise slowly through the water.

The lowest well (Spring e) is full to the lip, which is about seven feet below the apex of the mound. Bubbles of gas rise constantly, but irregularly. The cup is very irregular in shape, but is, roughly speaking, about twenty-five by fifteen feet across. The depth of water over the greater part is only three feet, but one portion, about five feet in diameter, is of greater depth—probably six or seven feet. The water leaks out over the rim in every direction, but chiefly towards the west, in streams with an estimated total sectional area of four hundred square inches.

The water in all the wells was too hot to touch, evidently not far from the boiling point; but, as I had no thermometer, I was unable to ascertain its exact temperature. Its taste, when cooled, was indescribably nasty, resembling what one could imagine to be that of water in which very much decayed fish had been boiled. The gaseous emanations from the largest well smelt distinctly of sulphuretted hydrogen, and twice only I got a whiff as of sulphur. A quantity of the water from Spring (d) was bottled and sent to the Government Analyst, whose report is as follows:—

Carbonates of calcium and magnesium ... ..	6.25	grains per gal.
Carbonates of sodium and potassium ... ..	15.94	" "
Chloride of sodium and potassium ... ..	32.61	" "
<b>Total fixed salts</b> ... ..	<b>54.80</b>	" "
<b>Volatile matter</b> ... ..	<b>2.80</b>	" "
<b>Total solids</b> ... ..	<b>57.60</b>	

Sulphuric acid, *trace*.

Sulphuretted hydrogen, 2.19 grains per gallon.

"The same is a chlorinated sulphuretted water, and possesses similar medicinal properties to that of Harrowgate (England), but in a lesser degree—to the extent of about one-seventh of the Harrowgate water.

"ROBERT MAX, F.C.S., Govt. Analyst."

Little less than the want of a thermometer did I regret the want of a bar of soap, with which I could have tried the experiment which has been successfully carried out in the Yellowstone Park (to such an extent, indeed, that it has become a public nuisance). Perhaps the next visitor may go better provided, and succeed in temporarily exciting the quiet springs into active geysers. Mr. Arnold Hague, of the United States Geological Survey, in an article on "Soaping Geysers," read in February, 1889, before the American Institute of Mining Engineers, after detailing his experiments on the "Chinaman," "Old Faithful," "Beehive," "Giantess," and other geysers, accounts for the artificial ebullition as follows:—"If soap or lie is thrown into most of the small pools, a viscous fluid is formed; and viscosity is, I think, the principal cause in hastening geyser action. Viscosity must tend to the retention of steam within

the basin, and, as in the case of the superheated waters, where the temperature stands at or above the boiling point, explosive liberation must follow. All alkaline solutions, whether in the laboratory or in Nature, exhibit, by reason of this viscosity, a tendency to bump and boil irregularly." It may be mentioned that the "Chinaman," like the Einasleigh Springs, is a mere hot spring, never seen in geyser action, except when excited by soap.

Round the margins of all the basins we found a little rim of remains of dragon-flies, beetles, centipedes, frogs, &c. These had the appearance of having been boiled, and a slight deposition of carbonate of lime had, in some cases, taken place on their harder parts. The deposition is evidently a slow process, some twigs, which had certainly been a long time in the water, being "petrified" only in a trifling degree. It would be interesting for a naturalist to ascertain how these animals met their deaths, but our time did not permit of such an investigation. Did the dragon-flies hover over the surface of the water, as is their custom, till they were overpowered by the gaseous emanations? Did the frogs leap into the inviting blue water in ignorance of its deadly temperature? I may mention that I have seen frogs sporting in the warm water issuing from some of the New Zealand hot springs.

The mound is composed of carbonate of lime, and is covered by semi-circular or oval basins forming a series of steps from the summit to the edge of the dome. The water overflowing from the wells pours into these cups one after another, and, decreasing in temperature as it recedes from its source, the cups afford natural baths in which an invalid may be immersed in water of any temperature he may fancy.

It is easy to see the cause of the formation of the cups in the comparative rapidity with which the calcareous sinter would form round the edges of any accidental hollow in which the water might lodge. The heightening and extension of the rim would gradually enlarge the cup till it contained so much water that the tendency of the overflow would be to wear *one* channel deep enough at last to drain the cup.

The calcareous sinter is light and spongy on the surface, but is tolerably compact in the interior. Loose in the bottom of the dry cups are shovelfuls of needles and spikes of calcite, each an aggregation of rhombohedral crystals. It may be remarked that the deposits of hot springs in other parts of the world are much more commonly siliceous than calcareous.

It must be confessed that there is little of the picturesque in the general appearance of the mound, which is not striking for its size, and is of a dirty white or drab colour; but, to the eye capable of dissociating colour from form, some of the cups are exquisitely beautiful in the freedom and originality of their curves. In this respect, at least, the Einasleigh mound and terraces will compare favourably with anything of the kind remaining in New Zealand since the destruction of the Rotomahana Terraces by the eruption of Tarawera.

Not the least singular thing about the Springs is the stream formed by their overflow. It gives rise to a narrow swamp on the surface of the alluvial flat, and runs parallel with the bank of the river for about half-a-mile. The bulk of the water empties into the river at the far end of the swamp, but portions of it form two distinct gullies discharging into the river nearest the Springs, and two still higher outlets, though now dry, evidently at times convey part of the stream. Whether this points to an increased flow from the Springs at times, or whether the volume of water in the swamp is simply increased during wet seasons, I cannot say.

It is in the highest degree unlikely that five distinct hot springs should rise from unknown depths to escape within an area which can be compassed by two hundred and sixty paces. It is much more probable that there was originally a single orifice, which



was gradually choked up by the deposition of sinter till it became insufficient for the passage of the water. The water would then have to find other outlets; though it is quite possible that a much greater volume of water would overflow if the deposit of sinter were removed either violently by a "convulsion" or by artificial means.

Assuming (as we may with safety) that the "bed-rock" on which the sinter mound is built up is not ten feet beneath the surface of the surrounding alluvium, we have a cone of known dimensions, and could roughly estimate the time required for the formation of the cone, knowing as we now do, from Mr. Mar's Analysis, the amount of lime and other salts held in solution by the water, and the amount of water discharged by the wells, if observations were carefully made to show the amount of solid matter held in solution by the water escaping beyond the limits of the mound. Here again, however, we should have to assume that the discharge of water was always the same as now, whereas it is probably diminishing, so that we should get as a result only a *minimum* time.

It now remains to consider the evidence bearing on the geological age of the Springs.

In a section from the Etheridge to the Einasleigh, taken on the level of the two rivers (both about 1,200 feet above the sea), mica-schists, gneisses, and granites alone would be met with. The mica-schists probably represent sedimentary rocks of pre-Devonian age, although I am not aware of any direct evidence to that effect; and the gneisses and granites, metamorphosed rocks of like origin and age. The granite largely predominates along the supposed line of section. But above the level of the two rivers, the Newcastle Range has been built up, from an elevation of 1,920 feet at its base to 2,240 feet near its summit, of a coarse angular volcanic agglomerate. On this rests a cake of Desert Sandstone (Upper Cretaceous), perhaps a hundred feet in thickness. A strictly parallel section is seen on crossing the Newcastle Range by the Townsville and Georgetown Road twenty-five miles to the south.

Large sheets of basalt occupy the bed of the Einasleigh and surrounding country where the river is crossed by the Townsville and Georgetown Road, and, lower down the valley, basaltic *coulées* are found overlying the older alluvial deposits, having been poured down the valley over the bed of the river, which at length cut through or found its way past the edge of the basalt. Similar fragments of basaltic *coulées*, it may be mentioned, occupy portions of the valleys of Surprise Creek and the Lynd River, on the road from Georgetown to Herberton.

It was after the denudation of the Desert Sandstone (Upper Cretaceous) and sub-jacent rocks had been carried on by the Einasleigh to the depth of a thousand feet that the lava-form basalts burst out and flowed down the valley. Probably no inconsiderable portion of Tertiary time was occupied by this stupendous amount of denudation; and it is more than probable that the volcanic forces which produced the outbursts of basalt may still, though diminishing, possess sufficient vitality to give rise to thermal springs.

In all likelihood, the Einasleigh Springs broke out in the bed of the river immediately after the denudation of the basalt—in the bed of the river by preference, because there the pressure of superincumbent rock offered the least resistance. The building of the sinter-mound would keep pace with the formation of the alluvial terrace when the river subsequently altered its course. In modern times the sinter is probably overlapping the alluvium.

*Innot Creek Hot Springs.*—These Springs are about twenty-eight miles from Herberton, a coach running once a week. A hotel has been built for the accommodation of visitors.

Mr. Ludwig Bruck in an Article in "The Mineral Springs of Australia,"<sup>1</sup> gives the temperature of these Springs as 149° F. and says—"The waters taken internally have an important action. But patients undergoing treatment combine bathing with the drinking of the waters, two or three baths of a duration of twenty to thirty minutes being taken daily. These Springs have already gained a considerable reputation for their curative virtues in chronic rheumatism, gout, liver and kidney diseases. But the Karisbad in Bohemia, the most celebrated Thermal Spa in Europe, the Hinc Hot Springs about 140 miles north-west of the stomach and intestines, dyspepsia, constipation, liverwurst, diseases of the genito-urinary organs, haemorrhoids, scrofula, &c. The principal spring in Karisbad is the "Sprudel" with a temperature of 177° or 178° lower than the Hinc Springs, while in mineral salts the Karisbad Springs are considerably richer."

Mr. A. G. G. Mitchell in a report on "The Coalfields, Tin Mines and Surrounding District,"<sup>2</sup> says—"Between Gunnavarra Station and the Hot Springs near Woodleigh, the road passes over rather flat sandy country, with scarcely a section visible. Probably the underlying country is granite. Within four miles of the Hot Springs portions of the country are occupied by basalt. In the vicinity of the Hot Springs, the prevailing country rock is a granite of variable composition and texture intersected by dykes of felsite and a rock not unlike a quartzite in appearance."

"The Springs are situated in the bed of Lind's or Nettle's Creek, a tributary of the Herbert River, and about two and three-quarter miles north-west of Woodleigh Station, at an altitude, by Aneroid of 1250 feet above Gunnavarra, or about 1900 feet above sea-level."

"Tradition has it that some years ago the present site of the Springs was occupied by a large waterhole full of sand overflowing with hot water."

"The only analysis of the water which is believed to have been made is that by the late Mr. Karl Staiger, sometime Government Analyst, who reported that the sample analysed by him contained 61.135 grains of solid matter in one gallon, viz.:-

Chloride of sodium	25.245
Alumina and iron	2.057
Carbonate of lime	2.304
Sulphate of lime	5.230
Silica	6.110
Insoluble solids	16.000
Organic matter	4.140
Losses	Trace

"This, however, must not be considered as conclusive, as it was made of a small quantity, quite insufficient for the purpose; it will be seen that Mr. Staiger does not even mention the carbonates of soda and magnesia which the water is known to contain—in fact, in one hundred parts of solids the carbonate of soda constitutes 12.5%."

"There appear to be at present two main outlets for the water at (a) and (y), while in two small holes hot water is met with, but overflows very feebly. The outlet (a) in the sandy bed of the creek, about nine feet from the eastern bank, is connected by piping with (y), which is about twenty feet further east. The outlet (a) has an elevation of from a foot to eighteen inches above the bed of the creek."

"Where the water emerges through the sand which fills the bed of the creek, a square tub has been inserted in the sand to collect it. The water overflows, and a good deal of it runs away down the creek."

<sup>1</sup> Australian Medical Gazette, January, 1881, p. 216.

<sup>2</sup> Extracted by Authority: 1881.

<sup>3</sup> L. Bruck, loc. cit.

"A fairly large quantity of gas, which has a slightly sulphurous odour, is constantly being given off with the water.

"For some distance round the orifice (*x*), the sand still retains a considerable portion of the heat derived from the percolation of the heated water through it. In some places it is nearly impossible to place one's hand in a hole dug in the sand to a depth of about eight inches. A considerable portion of the water from the main orifice still finds its way down the creek, by percolation through the sand without even rising to the surface.

"No deposit exists around the mouth, but many of the pebbles in the more immediate vicinity of the overflow are covered with an exceedingly thin white coating.

"The outlet (*y*) is on the bank of the creek, and a fair quantity of water rises and is allowed to overflow into (*x*), but no gas appears to be emitted from this outlet.

"The pool (*z*) is distant about twenty feet south of (*y*). It is about three feet by two feet across, and about ten to twelve inches deep. The temperature of the water is much below that of the other two sources, and the quantity of overflowing water is not nearly so great. The bottom of the pool is covered with a fine mud. Bubbles of gas rise almost continuously through the water.

"About thirty feet further south, on the bank of the creek, another pool similar to the last occurs. The water has a temperature slightly exceeding that of the surrounding air. Very little water overflows, and no gas is emitted."

*Mitchell River Mud Springs.*—In his Paper already quoted, Mr. E. Palmer mentions some springs, with similar characteristics to those on the Flinders, as occurring "about ten miles north of Gamboola Station, on the Mitchell River, with *Pandanus* growing very plentifully through them," and gives the following Analysis by Mr. Robert Mar, Government Analyst, of "a rather earthy sample of the saline incrustation" from these springs:—

	Per cent.
"Soda ... ..	37.54
Lime... ..	2.8
Oxide of iron ... ..	2.19
Sand... ..	31.72

"The acids are undetermined, but carbonic acid is chiefly represented. The water of the springs is alkaline carbonated."

*Inniskillen Hot Springs.*—Mr. E. Palmer, in his Paper on "Hot Springs and Mud Eruptions," already quoted, refers to "some small ones" on the Barcoo, below Inniskillen (between Tambo and Blackall).

Between Langlo Downs and Whitechapel Creek (approx. Lat. 25° 30' S. and Long. 145° 50' E.), I am informed by Mr. G. Neville Griffiths, several "extinct" mud springs have left mounds measuring about thirty feet in diameter at the base and about thirteen feet in height.

*Angy Springs, near Boulia, Lat. 22° 55' S., Long. 140° 25' E.*—I am also informed by Mr. Griffiths that at Angy, about twenty-seven miles east of Boulia, between Warrenda Creek and the Hamilton River, twenty or thirty strong springs are met with, forming large mounds of white soda. The water is clear and of normal temperature.

*Thargomindah Hot Springs.*—Hot mud springs are known to occur in the neighbourhood of Thargomindah, but I am unable to give any description of them. In a letter addressed to me on 21st September, 1889, the late Mr. C. S. Wilkinson referred to a ridge of granite and gneiss, standing island-like in the Cretaceous area, and added:—"This ridge lies chiefly on your side of the border, and is surrounded with mud springs, one of which is a thermal spring. Probably the water is coming up along the line of junction of the granite and Cretaceous beds."

*South Australia.*—To the above there may be added a short description of the South Australian Mound Springs by Mr. H. Y. L. Brown \* :—

"The mound springs, which are the natural indicators of artesian water beneath these plains,† are found in many places near the outcrops of bed rock,‡ between the junction of which and the Cretaceous rocks the water has doubtless found an easier egress. On the surface, the water often forms accumulations of travertine limestone rising to heights of forty or fifty feet, and showing in the distance across the level plains, where there is a group of springs, like a low range of hills; the deposition of this limestone has in many instances formed raised cups or basins, over the edges of which the water flows. The water of these springs contains soda, and is generally good drinking water; in some cases, however, in the same group of springs, there is a great difference in the quality of the water, which in one spring may be drinkable, and in another, a few feet away, salt. As a rule, these spring waters are warm, and must have a considerable temperature beneath the surface."

#### LIFE OF THE POST-TERTIARY AND RECENT PERIODS.

The following is the List, as revised by my Colleague, of extinct animals of whose existence in Queensland since the close of Tertiary times we have direct evidence. The names of such living animals as are associated with the extinct, in the same deposits, are also given. It is, however, not within the scope of this work to publish a Census of the present Fauna and Flora of the Colony.

The completeness of the break between the life of this Period and that of the older Cretaceous Period is the first circumstance to strike an observer. The absence of Tertiary organisms is equally noteworthy. The leading feature of the Fauna is the immense development of some forms of life which at present distinguish the fauna of Australia from all others, but which latter, after all, prove to be only a remnant of the peculiar assemblage of animals that flourished in the same area in Post-Tertiary times. Kangaroos, Wombats, Wallaroos, and other Marsupials were represented by a large number of species now extinct, and the Wingless Birds were in greater numbers than in the present day.

#### DIPROTODON BRECCIA, MARYVALE.

Class—PELECYPODA.

Order—VENERACEA.

<i>Corbicula nepeanensis</i> , Lesson	...	...	...	...	...	...	Freshwater, Living
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Class—GASTROPODA.

Order—PECTINIBRANCHIATA.

<i>Melania onca</i> , Adams and Angas	...	...	...	...	...	...	"
" <i>balonensis</i> , Conrad	...	...	...	...	...	...	"
" <i>denisoniensis</i> , Brot	...	...	...	...	...	...	"

Order—PULMONATA.

<i>Limnaea rimosa</i> ? Adams and Angas	...	...	...	...	...	...	"
<i>Physa truncata</i> , H. Adams	...	...	...	...	...	...	"

Class—REPTILIA.

Order—CROCODYLIA.

<i>Crocodylus porosus</i> , Schneider	...	...	...	...	...	...	"
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\* The Mesozoic Plains of South Australia. *Proc. Austr. Assoc. Adv. Sci.*, 1889, i., p. 243.

† The Rolling Downs.

‡ Mr. Brown evidently means by "bed rock" the Palaeozoic and Plutonic rocks underlying the Cretaceous.

## Class—MAMMALIA.

## Order—MARSUPIALIA.

<i>Diprotodon australis</i> , Owen	...	...	...	...	...	...	Extinct
<i>Macropus Titan</i> , Owen	...	...	...	...	...	...	"

## DARLING DOWNS.

## Class—GASTEROPODA.

## Order—PECTINIBRANCHIATA.

<i>Melania balonensis</i> , Conrad	...	...	...	...	...	...	Living
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## Class—PISCES.

## Order—DIPNOI.

<i>Ceratodus Fosteri</i> , Krefft	...	...	...	...	...	...	"
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## Class—REPTILIA.

## Order—CHROLONIA.

<i>Meiolania Oweni</i> , Smith Woodward	...	...	...	...	...	...	Extinct
<i>Chelodina longicollis</i> , Shaw	...	...	...	...	...	...	Living

## Order—LACERTILIA.

<i>Chlamydosaurus Bennettii</i> , Owen	...	...	...	...	...	...	Extinct
<i>Megania prisca</i> , Owen	...	...	...	...	...	...	"
<i>Varanus dirus</i> , De Vis	...	...	...	...	...	...	"
" <i>emeritus</i> , De Vis	...	...	...	...	...	...	"
<i>Notiosaurus dentatus</i> , Owen?	...	...	...	...	...	...	"

## Order—CROCODYLIA.

<i>Crocodylus porosus</i> , Schneider	...	...	...	...	...	...	Living
<i>Pallimnarchus pollens</i> , De Vis	...	...	...	...	...	...	Extinct

## Class—AVES.

## Order—CABINATÆ.

<i>Taphatus brachialis</i> , De Vis	...	...	...	...	...	...	"
<i>Necrastur alacer</i> , De Vis	...	...	...	...	...	...	"
<i>Pelicanus praeceus</i> , De Vis	...	...	...	...	...	...	"
<i>Palaeopelargus nobilis</i> , De Vis	...	...	...	...	...	...	"
<i>Platalea subtenuis</i> , De Vis	...	...	...	...	...	...	"
<i>Anas elapsa</i> , De Vis	...	...	...	...	...	...	"
<i>Dendrocygna validipennis</i> , De Vis	...	...	...	...	...	...	"
<i>Biziura exhumata</i> , De Vis	...	...	...	...	...	...	"
<i>Nyroca reclusa</i> , De Vis	...	...	...	...	...	...	"
" <i>robusta</i> , De Vis	...	...	...	...	...	...	"
<i>Plotus parvus</i> , De Vis	...	...	...	...	...	...	"
<i>Lithophaps ulnaris</i> , De Vis	...	...	...	...	...	...	"
<i>Progura gallinacea</i> , De Vis	...	...	...	...	...	...	"
<i>Chosornis prateritus</i> , De Vis	...	...	...	...	...	...	"
<i>Porphyrion? reperta</i> , De Vis	...	...	...	...	...	...	"
" <i>Mackintoshii</i> , De Vis	...	...	...	...	...	...	"
<i>Gallinula strenuipes</i> , De Vis	...	...	...	...	...	...	"
" <i>peralata</i> , De Vis	...	...	...	...	...	...	"
<i>Tritonyx effluxus</i> , De Vis	...	...	...	...	...	...	"
<i>Fulica prior</i> , De Vis	...	...	...	...	...	...	"
<i>Xenorhynchus nanus</i> , De Vis	...	...	...	...	...	...	"

## Order—RATITÆ.

<i>Dromaius patricius</i> , De Vis	...	...	...	...	...	...	"
" <i>gracilipes</i> , De Vis	...	...	...	...	...	...	"
<i>Dinornis queenslandica</i> , De Vis	...	...	...	...	...	...	"
<i>Metapteryx bifrons</i> , De Vis	...	...	...	...	...	...	"
<i>Chosornis prateritus</i> , De Vis	...	...	...	...	...	...	"

## Class—MAMMALIA.

## Order—MONOTREMATA.

<i>Ekidna Owenii</i> , Krefft ...	...	...	...	...	...	...	Extinct
<i>Ornithorhynchus agilis</i> , De Vis ...	...	...	...	...	...	...	55

## Order—MARSUPIALIA.

<i>Phascolomys medius</i> , Owen...	...	...	...	...	...	...	56
" <i>magnus</i> , Owen	...	...	...	...	...	...	56
" <i>Mitchelli</i> , Owen	...	...	...	...	...	...	56
" <i>parvus</i> , Owen	...	...	...	...	...	...	56
" <i>platyrhinus</i> , Owen	...	...	...	...	...	...	Living
" <i>Thomsoni</i> , Owen	...	...	...	...	...	...	Extinct
" <i>angustidens</i> , De Vis ..	...	...	...	...	...	...	57
<i>Phascolonius gigas</i> , Owen ...	...	...	...	...	...	...	57
<i>Scoparnodon Ramsayi</i> , Owen	...	...	...	...	...	...	57
<i>Nototherium Mitchelli</i> , Owen	...	...	...	...	...	...	57
" <i>inorme</i> , Owen	...	...	...	...	...	...	57
" <i>dunense</i> , De Vis	...	...	...	...	...	...	57
<i>Diprotodon australis</i> , Owen	...	...	...	...	...	...	57
" <i>minor</i> , Huxley	...	...	...	...	...	...	57
<i>Eucemia grata</i> , De Vis ...	...	...	...	...	...	...	57
" <i>robusta</i> , De Vis	...	...	...	...	...	...	57
<i>Phalanger procyonius</i> , De Vis	...	...	...	...	...	...	57
<i>Pseudochirus notabilis</i> , De Vis	...	...	...	...	...	...	57
<i>Koalemus ingens</i> , De Vis ...	...	...	...	...	...	...	57
<i>Archisonurus securus</i> , De Vis	...	...	...	...	...	...	57
<i>Thylacoleo carnifer</i> , Owen ...	...	...	...	...	...	...	57
<i>Macropus Titan</i> , Owen ...	...	...	...	...	...	...	57
" <i>affinis</i> , Owen	...	...	...	...	...	...	57
" <i>Ajax</i> , Owen	...	...	...	...	...	...	57
" <i>robustus</i> , Gould	...	...	...	...	...	...	57
" <i>sp. ind. (a)</i>	...	...	...	...	...	...	57
"       " <i>(b)</i>	...	...	...	...	...	...	57
<i>Leptoniagon gracilis</i> , Owen...	...	...	...	...	...	...	57
<i>Oephranter Cooperi</i> , Owen ...	...	...	...	...	...	...	57
" <i>Gouldii</i> , Owen	...	...	...	...	...	...	57
<i>Palorchestes Anaki</i> , Owen ...	...	...	...	...	...	...	57
<i>Pachysiagon Ferragus</i> , Owen	...	...	...	...	...	...	57
" <i>Oinel</i> , Owen	...	...	...	...	...	...	57
<i>Phascolagus altus</i> , Owen ...	...	...	...	...	...	...	57
<i>Procoptodon pusio</i> , Owen ...	...	...	...	...	...	...	57
" <i>Goliath</i> , Owen	...	...	...	...	...	...	57
" <i>Rapha</i> , Owen	...	...	...	...	...	...	57
<i>Protemnodon Anaki</i> , Owen ...	...	...	...	...	...	...	57
" <i>Anteus</i> , Owen	...	...	...	...	...	...	57
" <i>Mimas</i> , Owen	...	...	...	...	...	...	57
" <i>Og</i> , Owen	...	...	...	...	...	...	57
" <i>rachis</i> , Owen ..	...	...	...	...	...	...	57
<i>Sthenurus Atlas</i> , Owen ...	...	...	...	...	...	...	57
" <i>Brakus</i> , Owen	...	...	...	...	...	...	57
<i>Sthenomerus Choron</i> , De Vis	...	...	...	...	...	...	57
<i>Brachylestes Palmeri</i> , De Vis	...	...	...	...	...	...	57
<i>Trichis oscillans</i> , De Vis ...	...	...	...	...	...	...	57
<i>Synaptodon avorum</i> , De Vis	...	...	...	...	...	...	57
<i>Thylacinus spelaeus</i> , Owen ...	...	...	...	...	...	...	57
<i>Sarcophilus laniarius</i> , Owen	...	...	...	...	...	...	57
" <i>prior</i> , De Vis ...	...	...	...	...	...	...	57
<i>Dasyurus viverrinus</i> , Shaw ...	...	...	...	...	...	...	Living

Order—SIRENIA.  
*Chronosoon australe*, De Vis ... .. Extinct

Order—UNGULATA.  
*Procharus celer*, De Vis ... .. "

Order—PROBOSCIDEA.  
*Notoelephas australis*, Owen? ... .. "

#### EIGHT-MILE PLAINS, NEAR BRISBANE.

Class—PISCES.  
 Order—DIPNOI.  
*Ceratodus Fosteri*, Krefft ... .. Living

Class—REPTILIA.  
 Order—CROCODYLIA.  
*Pallimnarchus pollens*, De Vis ... .. "

#### CAIWAIRROO, NEAR THARGOMINDAH.

Class—AVES.  
 Order—RATITÆ.  
*Dromornis australis*, Owen... .. Extinct  
*Dromaius patricius*, De Vis ... .. "

#### PEAK DOWNS.

Class—AVES.  
 Order—RATITÆ.  
*Dromornis australis*, Owen ... .. "

#### OLSEN'S AND JOHANNSEN'S CAVES, ROCKHAMPTON.

Class—GASTEROPODA.  
 Order—PULMONATA.  
*Helix Cunninghamsi*, Gray ... .. Land, Living  
 „ *Incei*, Pfeiffer... .. "  
 „ *Whartoni*, Cox ... .. "  
 „ *Parsoni*, Cox ... .. "

#### RAISED BEACH, NUDGEE.

Class—PELECYPODA.  
 Order—OSTRACHA.  
*Ostrea pes-tigris*, Hanley ... .. Living  
 Order—ARCACHA.  
*Anomalocardia trapesia*, Deshayes. ... .. "

Order—PECTINIBRANCHIATA.  
*Potamides ebininus*, Bruguière. ... .. "  
*Natica plumbea*, Lamk. ... .. "

#### RAISED BEACH, TOWNSVILLE.

Class—CRUSTACEA.  
 Order—DECAPODA.  
*Thalassinia Emorii*, Bell. ... .. Extinct?

#### POST-TERTIARY DRIFTS.

##### STANTHORPE TIN FIELD.

The Stanthorpe Stream Tin Mines, on the borders of New South Wales, lie on the surface of a granitic tableland, at an average elevation of a little less than three thousand feet above the sea. The heads of the streams are shallow and swampy. Where the streams attain any magnitude they find it easy to wander among the soft decomposing surface of the granite country. The Severn, therefore, and its tributaries, such as Quatpot Creek, have exceedingly tortuous courses and deep alluvial deposits.

By far the greater part of the stream tin is in fine grains of the size of a pin's head and under, and almost always reveals under the lens some trace of an original crystalline condition. It contains a large proportion of the "ruby" and "amber" varieties. Together with quartz granules, it forms, as a general rule, the matrix of a coarse, imperfectly cemented conglomerate or gravel of quartz and granite pebbles. The pebbles are often rather squared than rounded. They are not of a nature to retain striations well, but the shape of some of them leads me strongly to suspect that their attrition might, in the first instance, have been due to glacial action. The crystalline fragments of felspar, which have frequently been carried into the wash along with the quartz and tin-stone, have in most cases decomposed into a stiff kaolin, which sometimes helps to keep the wash together.

The tin wash is for the most part confined to the layer of gravel or unconsolidated conglomerate lying directly on the bed-rock. This gravel is generally overlaid by a varying thickness (up to twenty-five feet or more) of gritty sand, which is occasionally interrupted by thin layers of gravel (with streaks of tin-stone) or of clay.

After an examination of the alluvial workings (in 1882), I concluded that the tin-stone, in its original matrix, must have been in the form of crystals, rarely of large size. The ore was probably *concentrated* by the weathering of its matrix—whether reef, lode, or dyke—and of the encasing granite country during a long period of gentle subaërial denudation, when the rains were never sufficiently heavy to remove the tin, or even the larger quartz stones, from the hillsides where they were left by the decay of their matrix. To this there apparently succeeded a limited period of heavy rainfall, or possibly of snow whose melting produced a rush of water sufficiently strong to "sluice" the general surface of the hill country, and to deposit its heavier materials (including the tin-stone) in the upper reaches of the Severn and its tributaries, while carrying off its finer particles to the plains of the south-west. To the now current period belong the accumulation, under temperate conditions, of the existing surface-wash on the hillsides (moderately rich in tin ore), and the deposition of the sand (almost destitute of tin ore) which overlies the tin wash in the streams.

Two distinct types of tin-bearing rocks are met with in the district—quartz reefs and igneous dykes.

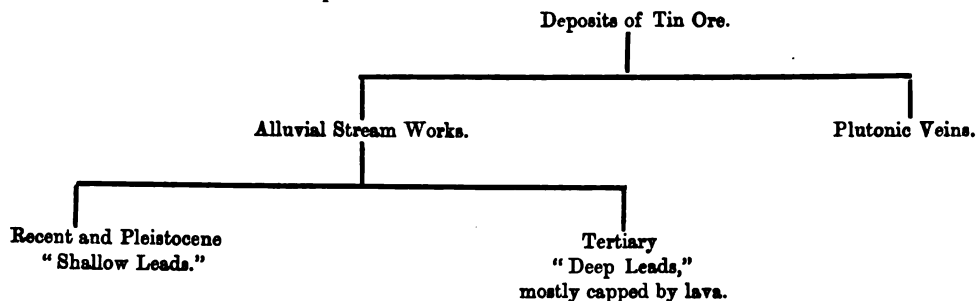
The reefs are best developed in the ridges on the left bank of Quartpot Creek, nearly opposite Sommerville's Homestead. Here are the outcrops of at least seven reefs or veins, four of which bear north-north-east, one north-east, and one east and west. These reefs are of highly crystalline quartz (sometimes smoky), and all contain much wolfram and moderate-sized crystals of tin ore, the latter almost always confined to faces and joints. Such reefs are apparently the sources of some of the coarser stream tin which is locally met with.

The dykes are composed of granular quartz, fine scaly lithia-mica, and small crystals of tin-stone, and form a rock much resembling the stanniferous greisen of Saxony. They seem to have been erupted in a molten condition (bringing up the tin oxide with them) among fissures in the granite. The tin-stone bears, in some samples I have seen, a proportion of five or ten per cent. to the general mass of the rock. Dykes of this character are seen at various points in the Range on the Boundary of the Colony between the heads of Kettle Swamp and Sugarloaf Creek. They run at varying angles from north-north-east to east-north-east, coinciding in their direction with a system of jointing which characterises the granite. The tin-ore crystals of the dykes are precisely what, with a little attrition, would form the main mass of the stream tin of the heads of the Severn.



Notwithstanding the richness of the alluvial deposits of Stanthorpe, no payable tin lode has yet been found on the Queensland side of the border.

The Stanthorpe Tin Field has never been geologically mapped in detail, but the exhaustive Report of Mr. T. W. Edgeworth David on the Vegetable Creek Tin Mining District of New South Wales throws considerable light on the subject. Mr. David classifies the stanniferous deposits as follows:—



### YIELD OF STANTHORPE TIN FIELD.

Year.	How Figures Obtained.	Tons of Stream Tin Ore raised.	Value £
1872	From Ann. Rep. Dep. Mines for 1885 ...	1,407	109,816
1873		8,938	606,184
1874		5,702	358,550
1875		4,475	237,879
1876		4,315	187,201
1877		3,335	133,432
1878		2,849	88,366
1879	Total in Queensland 2,877 tons, value £120,391; less Herberton 131½ tons, value £5,260 ... ..	2,745½	115,131
1880	Total in Queensland 2,847 tons, value £142,977; less Herberton 193½ tons, value £7,740 ... ..	2,653½	135,237
1881	Total in Queensland 3,456 tons, value £193,699; less Herberton 1,183½ tons, value £47,340 ... ..	2,272½	146,359
1882	Total in Queensland 4,261 tons, value £269,904; less Herberton 1,810 tons, value £72,400 ... ..	2,451	197,504
1883	...	817	40,233
1884	...	934	41,096
1885	...	503	25,150
1886	...	430	24,940
1887	...	356	22,072
1888	...	414	26,910
1889	...	310½	16,146
1890	...	277	14,404
Totals ... ..		45,185	2,526,610

1885.—Dept. Report and Return to Mr. Macrossan, 1886.

**MOUNT SPURGEON TIN FIELD.**

This field was discovered in 1886, and has not yet attained great importance. It is situated among slates and schists of undetermined age, although it is more than likely that they belong, like the Hodgkinson Gold Field, to the Gympie Formation. Lodes are known to exist, but the only export as yet has been stream tin ore. The "Annual Report of the Department of Mines" for 1888 gives the amount for 1887 as 60 tons, valued at £4,800; and for 1888, 370 tons, valued at £18,500. The "Report" for 1889 gives 130 tons, valued at £6,980, for the year. The Report for 1890 gives 34 tons, valued at £1,530.

**PASCOE TIN FIELD, CAPE YORK PENINSULA.**

Stream tin has recently been discovered near the mouth of the Pascoe, but the value of the discovery has yet to be tested. The tin ore probably came from the granite country of the Carron and Janet Ranges.

**J.**

## CHAPTER XXXVII.

## THE ORGANIC REMAINS OF THE POST-TERTIARY PERIOD.

We have seen that during the Cretaceous Period in Queensland, vertebrate remains were confined to those of Enaliosaurian and Chelonian Reptilia, and fragmentary remains of Fish. From this time onward, the geological record, palæontologically speaking, is a blank. No fossiliferous Tertiary beds have been discovered—certainly none of a marine origin. The “raised beaches” near Brisbane and Townsville, which my Colleague\* says “have been classed as Tertiary,”† are doubtless simply of Post-Tertiary age; whilst the existence of the Tertiary plant-beds described by the Hon. A. C. Gregory as met with on Darling Downs,‡ requires confirmation, notwithstanding the presence of “woody seed-vessels (*Conchotheca turgida*).” But, of the forerunners of the present Avi, Reptilian, and Mammalian Faunæ ample and wonderful evidence exists in the remains of the extinct, and frequently colossal vertebrates met with in the Post-Tertiary or Quaternary Fluvatile Drifts of Queensland. So little geological knowledge appears to have been displayed in the collection of these fossils, as to render them useless to the geologist, for any but the broadest stratigraphical generalisations.

The only important attempt at a detailed description of these drifts is by Mr. Gregory, under the name of “Older Alluvial or Fossil Drift,” but further information, with the view of an attempted classification of these fluvatile deposits, is very desirable.

On several occasions Mr. C. W. De Vis has hinted at his belief that some portion at least of the so-called Post-Tertiary Fauna should be regarded as appertaining to an older geological period—for instance, the Pliocene. I am not aware that Mr. De Vis has fully enunciated his views, but, no doubt, very much can be said in support of his suggestion.

The fresh-water Mollusca accompanying the ossiferous remains are all living species, so far as we know, but sufficient attention has not been paid by collectors to this important point.

## DESCRIPTION OF THE SPECIES.

## Kingdom—ANIMALIA.

## Sub-kingdom—ANNULOSA.

## Class—CRUSTACEA.

## Order—DECAPODA.

## Family—THALASSINIDÆ.

Genus—*THALASSINA*, Latreille, 1806.

(Gen. Crust. et Insect., i., p. 51.)

*THALASSINA EMERII*, Bell, Pl. 36, fig. 6.

*Thalassina Emerii*, Bell, Proc. Geol. Soc., 1844, iv., p. 360.

“ “ Etheridge fil., Cat. Australian Foss., 1878, p. 197 (for synonymy).

*Obs.* The original specimen was described simply as coming from “New Holland,” without any further indication of precise locality or horizon. Prof. Bell found some difficulty in fixing upon valid distinguishing characters between this species and the recent form *Thalassina anomala*, Herbst. (*T. scorpioides*).

\* Handbook Queensland Geology, 1886, p. 78.

† They were so described to me by the late Professor Denton, but from the first time I had an opportunity of seeing them I regarded them as comparatively recent “raised-beach” deposits. (R.L.J.)

‡ Report on the Geological Features of the South-eastern District of Queensland, p. 2. Brisbane: by Authority: 1879

From the time of Prof. Bell's description to the discovery of the specimen which came into my Colleague's hands, nothing else appears to have been added to the history of this peculiar fossil.\* The present example, of which only the abdominal somites and the legs are preserved, is contained in a blue limestone nodule. The three first pairs of legs are almost entirely preserved, especially the second pair, but of the fourth and fifth only small portions remain. The whole of the thorax has been removed, leaving the six abdominal somites turned under and adpressed against the remains of the legs. Neither the original figure nor the present specimen shows any trace of the lateral or sub-marginal ridges visible on the abdominal segments of the recent *T. anomala*. In a letter dated Townsville, May 27th, 1881, my Colleague says, speaking of the present fossil, "The nodule of limestone was picked up here, but I can throw no light on where it came from. I do not know of any limestone on the coast nearer than Temple Bay, and No. 6 Northumberland Island."†

*Loc. and Horizon.* Beach at Townsville (*B. L. Jack*)—Post-Tertiary or Recent?

## Sub-Kingdom—MOLLUSCA.

### Section—MOLLUSCA VERA.

#### Class—PELECYPODA.

#### Order—OSTRACEA.

#### Family—OSTREIDÆ.

#### *Genus*—OSTREA, *Linnaeus*, 1758.

(*Syst. Nat.*, Ed. x., p. 696.)

#### OSTREA PES-TIGRIS, *Hanley*, Pl. 36, figs. 7-9.

*Ostrea pes-tigris*, Hanley, *Proc. Zool. Soc.*, 1845, xiii., p. 106.

„ *mordax*, Gould, Wilkes' U.S. Explor. Exped., 1853, xii. (Mollusca and Shells), p. 464, *Atlas*, f. 575, a and b.

*Obs.* Several examples of a small Oyster, still retaining traces of the deep red purple colour characteristic of this species, as described by Gould, as well as the spatulate outline and solid structure, have been collected from Post-Tertiary deposits by my Colleague. The attached valve shows the "erect triangular tooth-like folds" for the reception of the digitations of the larger valve; and also the concentrically-arranged pits round the margin within the valve, together with the darkly-stained adductor-scar.

Authenticated specimens of *Ostrea pes-tigris*, Hanley, have been compared with the present specimens, and also recent Australian shells, by Mr. E. A. Smith and the Writer, and we believe them to be identical. Hanley's specimens were derived from Borneo, Gould's from Fiji, and, being identical, the former's name must be adopted.

Dr. J. C. Cox, in his Paper, "On the Edible Oysters found on the Australian and Neighbouring Coasts," says:—"This species is a rock oyster found adhering very firmly to the rocks by the whole of the lower valve, from Brisbane in Queensland to far north beyond Port Denison . . . and probably all along the coast north of Moreton Bay to Cape York, and at Lord Howe's Island."‡

*Loc. and Horizon.* Child's Vineyard, Nudgee, about nine miles from Brisbane (*B. L. Jack*)—Estuarine Beds (Raised-bench).

\* A number of specimens, apparently of the same species, were collected by the late Mr. James Smith, shortly before his death, at Casuarina Island, Keppel Bay. They occur in limestone nodules, and are now in the Geological Survey Collection, but have not yet been seen by my Colleague. (*R.L.J.*)

† These limestones are Palaeozoic. (*R.L.J.*)

‡ *Proc. Linn. Soc. N. S. Wales*, 1883, vii., p. 130.

## Order—ARCACEA.

## Family—ARCIDÆ.

Genus—*ANOMALOCARDIA*, Klein, 1753.

(Tentamen Meth. Ostracol.)

*ANOMALOCARDIA TRAPEZIA*, Deshayes, Pl. 36, figs. 10-12.*Arca trapezia*, Deshayes, Mag. Zool.,, *lobata*, Reeve, Conch. Icon. (Mon. Arca), 1844, ii., Sp. 19, t. 3, f. 19.*Anomalocardia trapezia*, Angas, Proc. Zool. Soc., 1867, p. 931.

*Sp. Char.* Shell obliquely-rhomboid, much produced posteriorly, and post-ventrally, gibbous and prominent in the umbonal region; test solid, inner margins strongly toothed. Hinge-line shorter than the width of the shell-area, which is elongately triangular, with two to four or five cartilage grooves, and transversely striate; teeth about forty-five in full-grown specimens; umbonal region convex and gibbous, projecting upwards much above the hinge-line; umbones anteally incurved. Anterior ends small, the margins obliquely rounded, insensibly passing into the ventral, which is similar; posterior sides variable in their proportions, sometimes abruptly sub-truncate, at others becoming expanded and rather flattened, with an obliquely elevated hinge-line, their margins rounded ventrally, and obliquely truncated more or less dorsally; muscular impressions strongly marked. Surface with numerous strong radiating ridges or costæ, quite two-thirds of which are inclined towards the posterior, and becoming much flattened on the posterior slope, crossed by concentric frillings, and rising on the costæ into echinations.

*Obs.* Amongst an abundance of this species is a shortened and very gibbous variety, with high elevated umbones, and greatly produced in a posterior ventral direction (Pl. 36, figs. 11 and 12), and in which the marginal crenulations are also very strong.

Reeve gives the locality of this common Australian shell wrong, as he does in so many other cases—viz., the West Indies. The National Collection in London contains numerous examples from the Brisbane Water, which entirely correspond with the fossil.

*Loc. and Horizon.* Child's Vineyard, Nudgee, about nine miles from Brisbane (*R. L. Jack*)—Estuarine Beds (Raised-beach).

## Order—VENERACEA.

## Family—CYRENIDÆ.

Genus—*CORBICULA*, Megerle, 1811.

(Berlin. Magazin, 1811, p. 56.)

*CORBICULA NEPEANENSIS*, Lesson.*Cyclas Nepeanensis*, Lesson, Voy. Coquille, Zoologie, 1830, ii., p. 428, Atlas, t. 13, f. 14, g-n.*Cyrena Australis*, Deshayes, Encyclop. Method., 1830, Vers. ii., No. 12, p. 50.*Corbicula Australis*, Deshayes, Cat. Conchif. Brit. Mus., 1854, p. 230.

,, ,, Daintree, Quart. Journ. Geol. Soc., 1872, xxviii., p. 274.

,, ,, Smith, Journ. Linn. Soc. (Zool.), 1883, xvi., p. 300, t. 17, f. 26 and 27.

*Obs.* This is probably the shell cited by the late Mr. Richard Daintree as occurring with *Diprotodon* remains at Maryvale Creek. The specimens of these freshwater shells are not forthcoming now, which is to be regretted, because fresh comparisons would have been advantageous.

*Loc. and Horizon.* Maryvale Creek, Clarke River, North Queensland (*The late R. Daintree*)—*Diprotodon-breccia*.

## Class—GASTEROPODA.

## Order—PECTINIBRANCHIATA.

## Family—MELANIIDÆ.

Genus—*MELANIA*, Lamarck, 1801.

(Syst. Anim. sans Vertèb., p. 91.)

*MELANIA ONCA*, A. Adams and Angas.

- Melania onca*, A. Adams and Angas, Proc. Zool. Soc., 1863, p. 415.  
 " Brod, Küster's Conchyl. Cabinet, Edit. 2, 1874, p. 330, t. 34, f. 7.  
 ? " *arca*, Daintree, Quart. Journ. Geol. Soc., 1872, xxviii., p. 274.  
 " *onca*, Smith, Proc. Linn. Soc. (Zool.), 1883, xvi., p. 259.

*Obs.* The name *Melania arca* occurring in Mr. Daintree's "Notes on the Geology of the Colony of Queensland" is probably a misprint for the above species.

*Loc. and Horizon.* Maryvale Creek, Clarke River, North Queensland (*The late R. Daintree*)—Diprotodon-breccia.

*MELANIA BALONENSIS*, Conrad.

- Melania Balonensis*, Conrad, Prod. Acad. Nat. Sc. Philadelphia, 1850, v., p. 11.  
 " " Conrad, American Journ. Conchol., 1866, ii., p. 80, t. 1, f. 10.  
 " " Brod, Küster's Conchyl. Cabinet, I., Edit. 2, 1874, p. 287, t. 28, f. 14, 14a and b, and 15.  
 " " Smith, Proc. Linn. Soc. (Zool.), 1883, xvi., p. 257, t. 5, f. 1-3.  
 " *pagoda*, Daintree (*non* Lea), Quart. Journ. Geol. Soc., 1872, xxviii., p. 274.

*Obs.* There appears to be much variation in size and appearance, both in the living and fossil individuals of this species, especially in form and stoutness, whilst a few of the fossils are more elongate than any of the recent examples in the British Museum. The former certainly appears to have grown to a larger size than the latter. This is probably the species recorded in Mr. Daintree's Paper as *Melania pagoda*, which is not known as an Australian living species.

*Loc. and Horizon.* King's Creek, Darling Downs, in Post-Tertiary deposits associated with extinct marsupial remains (*Dr. G. Bennett*—Colln. British Museum); Maryvale Creek, Clarke River (*The late R. Daintree*)—Diprotodon-breccia.

*MELANIA DENISONIENSIS*, Brod.

- Melania Denisoniensis*, Brod, Küster's Conchyl. Cabinet, Edit. 2, 1874, p. 234, t. 25, f. 6.  
 " " Smith, Journ. Linn. Soc. (Zool.), 1883, xvi., p. 259, t. 5, f. 4-8.  
 " *mæsta*, Daintree (*non* Hinds), Quart. Journ. Geol. Soc., 1872, xxviii., Pt. 3, p. 274.

*Obs.* In all probability this is the species mentioned by Mr. Daintree as *Melania mæsta*.

*Loc. and Horizon.* Maryvale Creek, Clarke River, North Queensland (*The late R. Daintree*)—Diprotodon-breccia.

## Family—CERITHIIDÆ.

Genus—*POTAMIDES*, Brongniart, 1822.

(Descrip. Géol. Environs Paris.)

*POTAMIDES EBININUS*, Bruguière, sp., Pl. 36, fig. 14-16.

- Cerithium ebininum* (Brug.), Deshayes, in Lamarck, Hist. Nat. Anim. s. Vertèb., 2nd edit., 1843, ix., p. 287.  
*Potamides ebininus*, Reeve, Conch. Icon. (Mon. *Potamides*), 1866, xv., Sp. 2, t., f. 2a, 2b, and 2.

*Sp. Char.* Shell elongately pyramidal; whorls twelve-fourteen, concave above, convex below; body-whorl usually highly varicated; sutures well marked; apex acute; angles of the whorls bearing a series of obtuse prominent tubercles, which fall into a

series of obliquely vertical lines, the surface being otherwise spirally ridged, the ridges and intervening sulci about equal, the former passing over the tubercles. Aperture much expanded; canal oblique, open and wide; outer lip very much foliated and thickened, with a sinuosity of greater or less depth; inner lip reflected, thickened above and beneath.

*Obs.* This fine species appears to occur in a fossil state near Brisbane in as great profusion as it does in the estuaries of the eastern coast of Australia at the present time. In some specimens the mouth is greatly thickened, especially the outer lip, forming a strong vaxex (Pl. 36, fig. 16). Its amount of sinuosity also varies, being very sharp in some specimens, and obtuse in others, when the lip is much thickened.

*Loc. and Horizon.* Child's Vineyard, Nudgee, about nine miles from Brisbane (*R. L. Jack*)—Estuarine Beds (Raised-beach).

### Family—NATICIDÆ.

*Genus*—*NATICA*, *Adanson*, 1757.

(*Hist. Nat. Sénégal*, Coquil, p. 172.)

*NATICA PLUMBEA*, *Lamarck*, Pl. 36, fig. 13.

*Natica plumbea*, *Lamarck*, *Hist. Nat. Anim. sans Vertéb.*, 1822, vi., Pt. 2, p. 198.

" " *Reeve*, *Conch. Icon. (Mon. Natica)*, 1855, ix., Sp. 34, t. 9, f. 34, a and b.

*Obs.* The fossil possesses the oblong-turbinate shape, conoid spire, infra-sutural flattened space on each whorl, and the narrow, elongate umbilicus of *Natica plumbea*.

*Loc. and Horizon.* Child's Vineyard, Nudgee, about nine miles from Brisbane (*R. L. Jack*)—Estuarine Beds (Raised-beach).

### Order—PULMONATA.\*

*Obs.* We are greatly indebted to Mr. Charles Hedley, F.L.S., for the following epitome of his views on the origin and distribution of the Australian Pulmonifera. As these have an interesting geological bearing we are glad to avail ourselves of the opportunity of inserting them †:—

"One of the most remarkable facts yielded by an analysis of the Australian Land Molluscan Fauna is that the operculate snails are confined to a narrow strip of land along the Queensland coast. Proceeding southwards from Torres Straits they diminish gradually till the last outpost of the invading army is reached about the Clarence River, in N. S. Wales. The sole apparent exception to this rule is *Truncatella*, which spreads to Tasmania and South Australia, but as this genus is strictly littoral, and evidently migrates not by land but by sea, it cannot be considered as a disturbing factor in my generalisation. Contrasting the fauna of Queensland with the more typically Australian and probably archaic fauna of Tasmania, Victoria, and Western Australia on the one side, and that of New Guinea on the other, it will be seen that this foreign aspect of the

\* In addition to the species enumerated here, Messrs. C. T. Musson and C. Hedley have recorded the following species from Olsen's Caves:—

*Helix (Charopa) iuloidea*, Forbes.

" (*Rhytida*) *splendida*, Pf.

" " " var. *strangeoides*, Cox.

*Pupina Cozi*, Morelet.

" *meridionalis*, Pf.

(See *Proc. Linn. Soc. N. S. Wales*, 1892, vi. (2), pp. 551-564.)

† Land Molluscan Fauna of British New Guinea (Anatomical Supplement). *Proc. Linn. Soc. N. S. Wales*, 1892, vi. (2), Pt. 4, p. 694.

operculate genera *Pupina*, *Helicina*, and *Diplommatina* is shared by the inoperculate forms of *Atopos*, *Hadra*, *Chloritis*, and *Papuina*; *A. prismaticus* of Papua claiming affinity with *A. australis* of Queensland, *H. Broadbenti* with *H. informis*, *C. chloritoides* with *C. Porteri*, and *P. naso* with *P. Macgillivrayi*. The species actually common to both regions are few; *B. Macleayi* inhabits both countries, *T. annula* only finds a place in the Queensland catalogue by courtesy, while *P. pedicula*, *S. gracilis*, *T. ceylanica*, *T. valida*, and *L. vitreum* are widespread throughout Polynesia. From these premises it may be deduced that this portion of the Queensland molluscan fauna, though isolated sufficiently long to have lost specific identity with that of Papua, has nevertheless been derived from it.

"The shallow sea of Torres Straits now severs this Continent from the adjoining Island. Were its bed raised but seven fathoms the two countries would be united, while an elevation of ten fathoms would form a wide bridge between them. When the marine life east and west of Torres Straits is better known it will be of interest to observe whether the influence of an ancient isthmus is still visible in any divergence between the fauna inhabiting the two areas.

"Further to the westward the coasts of Australia and New Guinea again converge, being separated by an arm of the Arafura Sea, which gradually shoals from a central depth of forty fathoms, and stretches for about a hundred and fifty miles between Cape Wessel in the Northern Territory, and Cape Valsche on the opposite shore of Dutch New Guinea.

"In the 'Transactions of the Royal Society of S. Australia' (vol. v., pp. 47-56), Professor Tate enumerates the Land and Freshwater Mollusca of tropical S. Australia. It is remarkable that whereas a third of the land shells of Papua, and a sixth of the land shells of Queensland, are operculate, his census includes no operculate land shells whatever. Thus, at the remote date when the ancestors of the present Queensland molluscan fauna migrated from New Guinea across the ancient isthmus that I suppose to have bridged Torres Straits, the Arafura Sea appears to have still presented an impenetrable barrier between the two countries. The former elevation of land in this region, if uniform from east to west, may therefore be calculated at more than seven and less than forty fathoms."

#### Family—LIMNÆIDÆ.

Genus—*LIMNÆA*, Lamarck, 1799.

(Prodrome—Mém. Soc. Hist. Nat. Paris, 1799.)

*Amphipeplea vinosa*, A. Adams and Angas, Proc. Zool. Soc., 1863, p. 415.

*Limnæa* (*Amphipeplea*?) *vinosa*, Smith, Journ. Linn. Soc. (Zool.), 1883, xvi., p. 273.

„ *rimosa*, Daintree, Quart. Journ. Geol. Soc., 1872, xxviii., Pt. 3, p. 274.

*Obs.* The name *Limnæa rimosa*, given in Mr. Daintree's Paper, probably refers to this species.

*Loc. and Horizon.* Maryvale Creek, Clarke River, North Queensland (*The late R. Daintree*)—Diprotodon-breccia.

Genus—*PHYSA*, Draparnaud, 1801.

(Tab. Moll. Terr. Fluv. France.)

*PHYSA TRUNCATA*, H. Adams.

*Physa* (*Ameria*) *truncata*, H. Adams, Proc. Zool. Soc., 1861, p. 144.

„ *truncata*, Daintree, Quart. Journ. Geol. Soc., 1872, xxviii., Pt. 3, p. 274.

„ (*Ameria*) *truncata*, Smith, Journ. Linn. Soc. (Zool.), 1883, xvi., p. 292.

*Loc. and Horizon.* Maryvale Creek, Clarke River, North Queensland (*The late R. Daintree*)—Diprotodon-breccia.



## Family—HELICIDÆ.

Genus—*HELIX*, *Linnaeus*, 1758.

(Syst. Nat., Ed., x.

*HELIX (PEDINOGYRA) CUNNINGHAMI*, *Gray*.*Helix Cunninghamsi*, Gray, Proc. Zool. Soc., 1834, p. 64." " Reeve, Conch. Icon. (Mon. *Helix*), 1852, vii., t. 7, f. 363.

" " Cox, Mon. Australian Land Shells, 1868, p. 52, t. 1, f. 5 and 5a.

" (*Pedinogyra*) *Cunninghamsi*, Pilsbury in Tryon, Man. Conch., 2d. Ser., vi., *Helicidæ*, iv., Pt. 21, 1890, p. 14, t. 2, f. 28-31.

*Obs.* A very large and remarkable shell, of which a much decorticated example was obtained by the late Mr. James Smith. It is now living around Port Curtis and Rockhampton. It is a depressed discoid, and very solid shell, with a scarcely prominent spire; four or five quickly-increasing whorls, the last being very wide and bluntly-keeled, and suddenly deflected in front. The umbilicus is very large and open, so as to form what Mr. L. Reeve calls "a wide perspective basin," this being one of the chief characters of the shell. The fossil has a diameter of three and three-quarter inches.

*Loc.* Olsen's Cave, Rockhampton, in red stalagmitic limestone (*The late James Smith*).

*HELIX (HADRA) INCEI*, *Pfeiffer*.*Helix Incei*, Pfeiffer, Proc. Zool. Soc., 1845, p. 126." " Reeve, Conch. Icon. (Mon. *Helix*), 1852, vii. t. 68, f. 356, a-c.

" " Cox, Mon. Australian Land Shells, 1868, p. 54, t. 5, t. 18, f. 1.

" (*Hadra*) *Incei*, Pilsbury, in Tryon, Man. Conch., 2nd. Ser., vi., *Helicidæ*, iv., Pt. 21, 1890, p. 167, t. 39, f. 77-81.

*Obs.* The sub-fossil form very closely resembles the figures of Reeve. It is a depressed-globose umbilicated shell, with a convexly-conoid spire; whorls are six in number, the last large and well-rounded, and the columellar margin reflected and nearly covering the umbilicus. The shell is finely preserved and encrusted with stalagmite.

*Loc. and Horizon.* Johannsen's Cave, Rockhampton, in stalagmite (*The late James Smith*).

*HELIX (HADRA) WHARTONI*, *Cox*.*Helix Whartoni*, Cox, Proc. Zool. Soc., 1871, p. 55, t. 3, f. 5, 5a." (*Hadra*) *Whartoni*, Pilsbury in Tryon, Man. Conch., 2nd. Ser., *Helicidæ*, iv., Pt. 21, 1890, p. 171, t. 19, f. 31, 32, t. 33, f. 68, 69.

*Obs.* This is an openly umbilicate, depressed-globose thin shell, with a rather raised spire; there are six and a-half flattened whorls, the last descending in front. The columellar margin of the aperture is triangular and dilated, half concealing the umbilicus. *H. Whartoni* is found around Port Denison. The shell is finely preserved in the fossil.

*Loc.* Johannsen's Cave, Rockhampton, in stalagmite (*The late James Smith*).

*HELIX (HADRA) PARSONI*, *Cox*.*Helix Parsoni*, Cox, Proc. Zool. Soc., 1872, p. 18, t. 4, f. 2." (*Hadra*) *Parsoni*, Pilsbury in Tryon, Man. Conch., 2nd Ser., vi., *Helicidæ*, iv., Pt. 21, 1890, p. 162, t. 85, f. 11-13.

*Obs.* *H. Parsoni* is described by Dr. Cox as a globose-conical shell, with an obtusely conical round spire, and a deep open umbilicus; whorls seven, convex; the suture margined with a distinct white line; the last whorl produced and deflected in front, and the base flattened. The aperture is ovately lunar, with a slightly thickened

peristome, expanded and reflected throughout; the collumellar margin triangularly dilated, and overhanging the large umbilicus. The specimen is a decorticated example.

*Loc.* Olsen's Cave, Rockhampton, in red stalagmitic limestone (*The late James Smith*).

*Genus*—*BULIMUS*, *Scopoli*, 1777.

(*Introd. Hist. Nat.*)

*Section*—*PLACOSTYLUS*, *Beck*, 1837.

(*Index Moll.*, p. 57.)

*BULIMUS (PLACOSTYLUS) FIBRATUS*, *Martyn*.

*Limax fibratus*, Martyn, Univ. Conch., 1734, t. 25.

*Bulimus fibratus*, Gray in Diffenbach, Travels in New Zealand, 1843, ii., p. 247.

„ *Bairdii*, Reeve, Conch. Icon. (Mon. *Bulimus*), 1848, v., t. 43, f. 272.

*Obs.* A specimen of this species, with a portion of the body-whorl wanting, was presented to the British Museum by the late Mr. R. Daintree, and was said to have been collected in "Australia." The section *Placostylus* has not hitherto been observed on the Australian Continent, although known from many of the Pacific Islands, and the fossil must therefore remain doubtfully associated with its former fauna. An error may have been committed, but as Mr. Daintree was known to be a careful collector and keen observer, the species is provisionally included amongst the latter. The specimen retains the coarsely rugate appearance of *B. fibratus*, and is preserved in a fine ochre-yellow sandy matrix.

## Sub-kingdom—VERTEBRATA.

### Class—PISCES.

### Order—DIPNOI.

### Family—LEPIDOSIRENIDÆ.

*Genus*—*CERATODUS*, *Agassiz*, 1838.

(*Poissons Foss.*, iii., pp. 129 and 166.)

*CERATODUS FORSTERI*, *Krefft*.

*Ceratodus Forsteri*, Krefft, Proc. Zool. Soc., 1870, p. 221, p. 222, f. 1-3.

„ „ Gunther, Phil. Trans., 1872, clxi., Pt. 2, pp. 511 and 514, t. 30, f. 2 and 3, t. 31, f. 1-9, t. 32, f. 1 and 2, t. 33, f. 1-3, t. 34, f. 1-3, etc.

„ *Palmeri*, Krefft, Nature, 1874, ix., p. 293.

„ *Forsteri*, Huxley, Proc. Zool. Soc., 1876, p. 24.

„ „ De Vis, Proc. R. Soc. Queensland, 1884, i., Pt. 1, p. 40.

„ „ Smith Woodward, Cat. Foss. Fishes Brit. Mus., Pt. 2, 1891, p. 274.

*Obs.* The late Mr. Gerard Krefft appears to have been the first to call attention to the fossil remains of this very remarkable genus. In a short communication forwarded to "Nature" he recorded the discovery of the left upper dental plate of a *Ceratodus*, to which he applied the name *C. Palmeri*, on the grounds that the tooth was larger than the corresponding one in *C. Forsteri*, the enamel coarser, and the surface more undulated.

The single tooth acquired by Mr. Krefft has since been supplemented by others obtained for the Queensland Museum, consisting of four pterygopalatine plates and five mandibulary. Of these teeth Mr. De Vis states—"We can perceive an approximate similarity in their leading features, which enables us to avoid the error of considering them all of different species, and leads us to regard them as not only one, but one with the living *C. Forsteri*."

*Loc. and Horizon.* Darling Downs (*C. W. De Vis*, Colln. Queensland Museum)—Chinchilla Conglomerate. A *Ceratodus* tooth has also been obtained at the depth of about seventy feet from a well sunk in the Eight-mile Plains, near Brisbane.

## Class—REPTILIA.

## Order—CHELONIA.

## Family—MEIOLANIIDÆ.\*

## Genus—MEIOLANIA, Owen, 1886.

(Proc. R. Soc., xl., p. 315.)

## MEIOLANIA OWENI, Smith Woodward.

*Megalania prisca*, Owen, Phil. Trans. 1881, clxxi., Pt. 3, p. 1037, t. 37, f. 1, t. 38, f. 1-3.

" " Owen, *Loc. cit.*, clxxii., Pt. 2, p. 547, t. 64, t. 65, f. 1-4.

*Ceratochelys sthenurus*, Huxley, Proc. R. Soc., 1887, xliii., p. 237 (Queensland cranium and tail-sheath).

*Meiolania Oweni*, Smith Woodward, Ann. and Mag. Nat. Hist. 1888, i., p. 89.

*Meiolania Oweni*, Lydekker, Cat. Foss. Reptilia and Amphibia Brit. Mus., Pt. 3, 1889, p. 166.

*Obs.* A few pages further on will be explained the restriction which has been made in the use of the name *Megalania prisca*, Owen. It appears that it originally included—(a), lacertilian vertebræ, and an occipital fragment; (b), a chelonian skull and tail-sheath; and (c), marsupial foot-bones. The name is now restricted to the first of these, the chelonian skull and tail-sheath being referable to Owen's later described genus *Meiolania*.

This skull, found by Mr. G. F. Bennett in 1871, at King's Creek, Darling Downs, was spoken of by Sir Richard Owen as that of a Lacertilian, in the following words—"They [*i.e.*, the pieces] included unquestionable horn-cores, and the fore-part of an upper jaw, showing no trace of teeth or sockets on the alveolar border. . . . On restoring the cranium, as far as its transmitted fragments could be correctly juxtaposed, it manifested, in one part, not only a well-defined surface from which an apparently autogenous horn-core, as in the Giraffe, had become detached, but also pairs of exogenous ones like those of the Ox. The longest of these extended from the upper and side borders of the hinder portion of the cranial specimens, but evidently anterior, as in the Bison, to the occipital ridge. The surface, seemingly for the sutural attachment of a horn-core, was on the upper part of the nasal bone, symmetrical in shape, crossing the mid-line, like the horn of a Rhinoceros." Only in the small Australian Lizard—*Moloch horridus*, Gray—could Owen find a head "resembling in its proportionate breadth and shortness that of *Megalania*."

The tail-sheath was found in 1881, at the same spot as the previous specimen, and was referred by Owen to the same animal. The specimen included three annular segments, and the terminal cap of an osseous sheath. "Each of the annular segments," says Prof. Owen, "sends off two pairs of massive conical processes, like the horn-cores of the skull, but of a larger size. This caudal armour resembles that seen in *Uromastix princeps*, O'Shaughn., from Zanzibar, and more particularly still that of *Moloch horridus*, Gray." These remains were obtained by Mr. G. F. Bennett at King's Creek, Darling Downs.

The researches of Prof. Huxley † on other similar remains from Lord Howe Island, named *Meiolania platyceps* and *M. minor* by Prof. Owen, ‡ and having the greatest

\* Boulenger, Proc. Zool. Soc. 1887, Pt. 3, p. 554; Gunther, Encyclop. Brit., 9th Edit., 1888, xxiii., p. 457. •

† Proc. R. Soc., 1887, xliii., p. 237.

‡ Phil. Trans., 1886, clxxvii., Pt. 2, p. 471, t. 29-31.

possible resemblance to the skull from King's Creek, but smaller in size, appear to put it beyond doubt that these fossils are Chelonian and not Lacertilian. They are believed to be most nearly allied to *Chelydra* and *Gypochelys*, Cryptodiran genera. A full explanation of this matter will be found a few pages further on.

The occurrence of this genus of Chelonia in Queensland is exceedingly interesting, because the section of the order to which it appertains is not otherwise represented in Australia. This statement of Prof. Huxley's has been controverted by Mr. G. A. Boulenger,\* who considers that *Meiolania* is a member of the group to which the Australian forms belong—viz., the Pleurodira. The balance of evidence, however, favours Prof. Huxley's view.† In concluding a brief review of this subject Mr. R. Lydekker makes the following pertinent remarks‡:—"Perhaps the acquisition of the plastron may be necessary before we can be absolutely certain as to the Pleurodiran nature of *Meiolania*, but in the first place distributional evidence is very strongly in favour of this view, while the osteological evidence adduced by Boulenger seems still more so. That the genus represents a distinct family there can be no question whatever.

*Loc. and Horizon.* King's Creek, Darling Downs (*G. F. Bennett*—Colln. Brit. Mus.)—Fluviatile deposits.

#### Family—CHELYIDÆ.

*Genus*—*CHELODINA*, *Fitzinger*, 1826.

(N. Class Rept., p. 6.)§

#### *CHELODINA LONGICOLLIS*, *Shaw*.

*Testudo longicollis*, Shaw, Gen. Zool., 1802, iii., p. 62, t. 16.

*Chelodina longicollis*, Gray, Syn. Rept., 1831, p. 39.

" " Lydekker, Cat. Foss. Reptilia and Amphibia Brit. Mus., 1889, Pt. 3, p. 168.

*Obs.* The British Museum Collection contains an imperfect nuchal bone, a tenth marginal bone of the right side, and a small right humerus, said to be of this species.

*Loc. and Horizon.* Westbrook, branch of Oakey Creek, Condamine River (*Dr. G. Bennett*—Colln. Brit. Mus.)—Fluviatile deposits.

#### Order—LACERTILIA.

#### Family—AGAMIDÆ.

*Genus*—*CHLAMYDOSAURUS*, *J. E. Gray*, 1827.

(P. P. King's Survey, Coasts of Australia, ii., p. 424.)

#### *CHLAMYDOSAURUS BENNETTII*, *Owen*, m.s.

*Chlamydosaurus Bennettii*, Owen in Bennett, Papers and Proc. R. Soc. Tas. for 1875 [1876], p. 57.

" *Kingi*, Lydekker (*non Gray*), Cat. Foss. Reptilia and Amphibia Brit. Mus., Pt. 1, 1888, p. 276.

*Obs.* The Frilled Lizard (*C. Kingii*, Gray), appears to be represented in the Quaternary Deposits of Queensland by an extinct species which has received the *ms.* name of *C. Bennettii*, Owen.

The remains, consisting of part of a jaw with teeth, were found by Mr. G. F. Bennett, and forwarded to Prof. Sir R. Owen, but the fragment has never been

\* Proc. Zool. Soc., 1887, Pt. 3, p. 554; Ann. and Mag. Nat. Hist., 1889, iii., p. 138.

† See Bauer, Ann. and Mag. Nat. Hist., 1889, iii., p. 54.

‡ Cat. Foss. Reptilia and Amphibia Brit. Mus., Pt. 3, 1889, p. 160.

§ *Fide* Lydekker, Cat. Foss. Reptilia and Amphibia Brit. Mus., Pt. 3, 1889, p. 168.

described in detail. The extinct species differs from its living representative, Dr. G. Bennett says, by possessing a shorter, more obtuse, and higher head. On the other hand, Mr. R. Lydekker states that it does not show any characters by which it can be distinguished from the living species.

*Loc and Horizon.* Gowrie Station, Darling Downs (G. F. Bennett)—Fluviatile deposits.

### Family—VARANIDÆ.

*Genus*—*MEGALANIA*, Owen, 1858.\*

(Proc. R. Soc., ix., p. 273.)

### *MEGALANIA PRISCA*, Owen.

*Megalania prisca*, Owen, Proc. R. Soc., 1858, ix., p. 273.

" Owen, Phil. Trans., 1860, cxlix., p. 43, t. 7, f. 1-4, t. 8, f. 1-4; *Ibid.*, 1881, clxxi., Pt. 3, p. 1037, t. 34, f. 1-2, t. 35, ff. 1-4, t. 36, f. 1-2; *Ibid.*, 1886, clxxvii., Pt. 1, p. 327, t. 13.

*Megalania* (?) *Varanus* *prisca*, Smith Woodward, Ann. and Mag. Nat. Hist., 1888, i., p. 89.

*Varanus priscus*, Lydekker, Cat. Foss. Reptilia and Amphibia Brit. Mus., 1888, Pt. 1, p. 284.

? *Megalania* (Vertebræ, ribs, fibula, and ulna) De Vis, Proc. R. Soc. Queensland, 1889, vi., Pts. 2 and 3, p. 94.

*Obs.* The above name was originally applied by Sir Richard Owen to three vertebræ of a land lizard surpassing in bulk the largest existing species, and equal in size to those of the largest living Crocodiles, representing an individual of not less than twenty feet in length. Prof. Owen arrived at these conclusions by a comparison of measurements between the fossils and similar parts of the great Lace Lizard of Australia, *Varanus* (*Hydrosaurus*) *giganteus*, Gray. The vertebræ in question were obtained on a branch of the Condamine River, and were purchased for the British Museum.

The second contribution to our knowledge of this peculiar lizard contained descriptions of an entire dorsal vertebra from the Darling Downs, forwarded to Sir R. Owen by Dr. George Bennett; some sacral vertebræ, and an expanded end of a scapula from the neighbourhood of Melbourne, obtained by Mr. F. M. Raynal; caudal vertebræ from Gowrie, Darling Downs, from Mr. St. Jean, with the occipital segment of the skull from the same locality; and lastly the anterior portion of a skull found by Mr. G. F. Bennett, in 1871, at King's Creek, Darling Downs. Subsequent to, and including the last discovery, other bones were referred to *Megalania* by Sir Richard Owen, but unfortunately in his earnest and enthusiastic zeal he united under one name remains from widely separated localities, and obtained at irregular intervals. The oversight which Prof. Owen committed in this respect has been unravelled with marked ability by Mr. Smith Woodward, and I cannot do better than quote his remarks *in extenso*. Speaking of the cranium found by Mr. G. F. Bennett, he says—"The latter fragments were *hypothetically* assigned to the same *genus* and species† as the original fossils discovered in 1858, and the presence of bony horn-cores upon the skull led to a comparison with the small Australian *Moloch horridus*, which is also provided with dermal horns, though never of an osseous character. A restoration of *Megalania* was given upon the assumption that the extinct and surviving types were closely allied. In 1881 a tail completely ensheathed in bony armour like that of *Glyptodon*, was found at the same spot in King's Creek whence had been obtained the fine portion of skull described in the previous year, and this, too, was determined‡ as belonging to what had now become known as the 'Great Horned Lizard.' *Uromastix princeps*, from Zanzibar, was next compared with the fossil, and Sir Richard Owen pointed out that

\* Restricted, Smith Woodward, 1888.

† *I.e.*, *Megalania prisca*.

‡ Phil. Trans., 1881, clxxii., Pt. 2, p. 547, t. 64.

the caudal armour of this lizard only differed from that of *Megalanian* in the same manner as the horns of *Moloch* were distinguished from those upon the Queensland skull—namely, in the absence of bony tissue in their structure. The tail of *Moloch horridus* was also shown to be encased in horny scutes similarly disposed, these even 'more closely repeating the number and arrangement of *Megalanian*' than the scutes of *Uromastix*. Still another contribution was made to the subject in 1886,\* when a sacral vertebra from Gowrie, Darling Downs, was described, and also a number of foot bones, supposed to show that *Megalanian prisca* was truly terrestrial, with well developed claws. . . . A number of fossil remains from a superficial coral-sand formation in Lord Howe Island . . . were soon found to comprise parts of an animal very similar to the possessor of the horned head and armoured tail already known from a locality four hundred miles distant in Queensland. Of these specimens Sir Richard Owen† described and figured portions of the skull and mandible, the tail and the partly restored pelvis, besides briefly noticing an anterior vertebra, a portion of a scapula, and a fragment of humerus. He concluded that they belonged to a new sub-genus—perhaps a new genus—to be named *Meiolania*, comprising apparently two species—*M. platyceps* and *M. minor*. Associated with the described fossils, however, were numerous other fragments which Mr. William Davies had placed amongst the Chelonia; and the whole were subsequently re-examined by Professor Huxley, who arrived at the conclusion that they were all Chelonian.‡ The animal was now considered to be most nearly allied to *Chelydra* and *Gypochelys* (*Macroclermys*), and other Cryptodiran genera of that type, and Mr. G. F. Bennett's Queensland skull and tail were unhesitatingly removed from their association with the Megalanian vertebræ, and referred to this new genus, for which Professor Huxley thought the name of *Ceratochelys* would be more appropriate than that of *Meiolania*. He also re-named *Meiolania platyceps*, *Ceratochelys sthenurus*. A new element was thus added to the reptilian fauna of Pleistocene Australia, the Cryptodiran Chelonia being totally unrepresented there, both at the present day and among known fossils from the superficial deposits. Still more satisfactory specimens of *Meiolania platyceps* afterwards reached Sir Richard Owen, who again presented descriptions to the Royal Society, and concluded that the animal displayed affinities both with the 'orders Chelonia and Sauria,' but was more nearly allied to the latter. . . . Another contribution to the correct interpretation of the 'Megalanian' fossils is unwittingly made by Mr. Lydekker in the last volume of his Fossil Mammalia Catalogue just issued. Among the foot-bones assigned to uncertain members of the marsupial families of *Nototheriidae* and *Phascolomyidae* are included specimens precisely similar to those described by Sir Richard Owen in Part iv. of his Memoir on *Megalanian*, as affording information in regard to the characters of the feet of this reptile. . . . It thus appears that under '*Megalanian prisca*' have been included (i.) lacertilian vertebræ and an occipital fragment; (ii.) a chelonian skull and tail sheath; and (iii.) marsupial foot-bones. The first necessarily form the type specimens of the genus and species, and the last are obviously at once excluded from consideration. The second series of fossils, however, require a name.

"Professor Huxley, as already remarked, unhesitatingly places Mr. Bennett's Queensland skull and tail in the same genus as the Lord Howe Island fossils, and the reference appears fully justified by the specimens at present known. . . . The rules of nomenclature do not permit of the adoption of a new name *Ceratochelys*, however appropriate it may be, and the genus must henceforth be termed *Meiolania*.

\* Phil. Trans., 1886, clxxvii., p. 327, t. 13-15.

† Ibid., p. 471, t. 29 and 30.

‡ Proc. R. Soc., 1887, xliii., p. 232.

"With regard to species, the figures and descriptions of the Queensland specimens are at once conclusive of their distinctness from any form yet determined from the distant Lord Howe Island, though they were not specifically distinguished or named by Professor Huxley. They are thus at present nameless; and I would venture to suggest that they may be appropriately known as *Meiolania Oweni*."

Mr. C. W. De Vis, the able Curator of the Queensland Museum, had, however, without any knowledge of Mr. Smith Woodward's views, arrived at a precisely similar opinion \* touching the Lacertilian character of the bones on which *Megalania* was originally established, and that the "attribution to it of a horned skull is untenable."

Notwithstanding the fact that both Messrs. Smith Woodward, Lydekker, and De Vis appear to regard *Megalania*, Owen, as restricted, simply as a *Varanus*, or Gigantic Monitor, I have for convenience' sake, and until the discovery of further and more complete remains, retained the generic appellation.

The vertebræ, remarks Mr. R. Lydekker, agree in general character with those of *Varanus sivalensis*, Falconer, but attain three times the dimensions.

*Loc. and Horizon.* Branch of the Condamine River (Colln. Brit. Mus.); Gowrie, Darling Downs (*Mr. St. Jean*)—Fluviatile deposits.

#### Genus—*VARANUS*, *Merran*, 1820.

(Tent. Syst. Amphib., p. 58.)†

#### *VARANUS DIRUS*, *De Vis*.

*Varanus dirus*, De Vis, Proc. R. Soc. Queensland, 1889, vi., Pts. 2 and 3, p. 98.

*Obs.* Founded on a large Varan tooth, in which the compression usually seen in representatives of this genus is carried to an unusual extent. "Its height and breadth at the base are thrice those of a corresponding tooth of *V. varius*—wherefore, on the assumption of like proportions throughout, it represents a Varan of about sixteen feet in length."

*Loc. and Horizon.* King's Creek, Darling Downs (*R. W. Frost*—Colln. Queensland Mus.)—Fluviatile deposits.

#### *VARANUS EMERITUS*, *De Vis*.

*Varanus emeritus*, De Vis, Proc. R. Soc. Queensland, 1889, vi., Pts. 2 and 3, p. 98.

*Obs.* Lacertilian remains consisting of portions of a humerus and tibia. The humerus is "from an adult individual, and indicates a species not greatly larger than an average *V. varius*; the tibia represents an individual nearly one-half as large again."

*Loc. and Horizon.* King's Creek, Darling Downs (*R. W. Frost*—Colln. Queensland Mus.)—Fluviatile deposits.

#### Genus—*NOTIOSAURUS*, *Owen*, 1884.

(Proc. R. Soc., xxxvi., p. 221.)

#### *NOTIOSAURUS DENTATUS*, *Owen*.

*Notiosaurus dentatus*, Owen, Proc. R. Soc., 1884, xxxvi., p. 221.

" " Owen, Phil. Trans., 1884, clxxv., Pt. 1, p. 249, t. 12.

? " " De Vis, Proc. R. Soc. Queensland, 1885, ii., Pt. 1, p. 25, t. 1-3 (humerus and scapula);

" " De Vis, *Ibid.*, 1889, vi., Pt. 2 and 3, p. 97.

*Obs.* The remains of a Pleurodont Lacertilian, consisting of "the outer end of a dentary element of the mandible," with portions of two teeth *in situ*, were described

\* Proc. R. Soc. Queensland, 1889, vi., Pts. 2 and 3, p. 97.

† *Fide* Lydekker, Cat. Foss. Reptilia and Amphibia Brit. Mus., 1883, Pt. 1, p. 231.

under the above name from Cuddie Springs, Co. Clyde, New South Wales. These were compared with the living Australian Lizard, *Varanus (Hydrosaurus) gigas*. Mr. C. W. De Vis has since hypothetically referred to *Notiosaurus* a left humerus and scapula, representing a reptile with a "probable length of fifteen feet," and a tooth. The latter resembles in outline that of *Hydrosaurus*, but is proportionately thicker.

The tooth is from Darling Downs, but the localities of the bones are not stated; but it is quite clear they were obtained at widely separated places, for Mr. De Vis says, speaking of the scapula—"which, from wide difference of locality, could not have belonged to the same individual as the humerus."

Although the bones described by Mr. De Vis may represent a large Lacertilian, related to *Hydrosaurus* or *Monitor* (= *Varanus*), to place them definitely with the species *N. dentatus* is perhaps a little premature. It would have been better to have referred these bones to a distinct genus.

*Loc. and Horizon.* The tooth at Clifton, Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Mr. De Vis informs me that the bones came from Pilton and Chinchilla—Fluviatile deposits.

## Order—CROCODYLIA.

### Family—CROCODYLIDÆ.

#### Genus—*CROCODYLUS*, *Laurenti*, 1768.

(Spec. Med. Exhib. Synop. Reptilium)

#### *CROCODYLUS POROSUS*, *Schneider*.

*Crocodylus porosus*, Schneider, Hist. Amphib., Pt. 2, 1801, p. 159.

" " Lydekker, Cat. Foss. Reptilia and Amphibia Brit. Mus., Pt. 1, 1888, p. 59.

*Obs.* The British Museum Collection contains portions of the right maxilla, teeth, dermal scutes, and caudal vertebræ, which Mr. R. Lydekker refers to this species.

Teeth were found by the late Mr. R. Daintree in the Diprotodon-breccias of Northern Queensland, and called by him *Crocodylus australis*, but in all probability they were those of *C. porosus*, mentioned in the British Museum Catalogue as presented by "Sir" R. Daintree.\* Mr. Daintree remarked that the Crocodile had, during the Quaternary Period, a greater inland range than it has now.

*Loc. and Horizon.* Maryvale Creek, Lat. 19° 30' S. (*The late R. Daintree*—Colln. Brit. Mus.); Clifton Plains, Darling Downs (*The late Prof. Harkness*—Colln. Brit. Mus.); Diprotodon-breccia, Gowrie, Darling Downs (*Dr. G. Bennett*—Colln. Brit. Mus.)—Fluviatile deposits.

#### Genus—*PALLIMNARCHUS*, *De Vis*, 1886.

(Proc. R. Soc. Queensland for 1885, ii., Pt. 2, p. 181.)

#### *PALLIMNARCHUS POLLENS*, *De Vis*.

*Pallimnarchus pollens*, De Vis, Loc. cit., p. 191.

*Obs.* Speaking of the occasional occurrence of Crocodilian fragments in the Queensland drifts, Mr. De Vis says:—"Recently, however, more instructive cranial and mandibular fossils have been met with, and it may now be no longer premature to invite

\* Strange to say, the late Mr. Richard Daintree, C.M.G., &c., is frequently spoken of by Mr. Lydekker as "Sir R. Daintree." The same mistake is committed by Mr. R. A. F. Murray, in his "Geology and Physical Geography of Victoria." (8vo. Melbourne, 1887.)



attention to the evidence they give in favour of two conclusions—first, that the saurian member of the past fauna was not identical with either of the two crocodilians in the present one; second, that it was not even nearly allied to them." Portions of the skull, both young and adult, jaws, teeth, and scutes are described.

Mr. De Vis' conclusions are—"No doubt remains that the fossil species was one distinct from the Indo-Australian, and probably eedemic, *Crocodilus porosus* on the one hand, and from the saurian peculiar to our northern tableland on the other . . . it appears that the portions of skull examined do not, in their imperfect condition, present a combination of characters exclusively alligatorian, nor on the other hand distinctly crocodilian; but that if we allow this seeming equilibrium of testimony to be disturbed by the weight derived from the imbrication of the scutes, the beam must sink at once on the side of the American family."

*Loc. and Horizon.* Chinchilla, Gowrie Creek, Wiembilla Creek, Condamine River, and Eight-mile Plains, near Brisbane (*C. W. De Vis*—Colln. Queensland Mus.)—Fluviatile deposits.

### Class—AVES.

*Obs.* According to Mr. C. W. De Vis,\* twenty-four genera of birds, containing twenty-eight species, are now known from Queensland deposits. Seven of the genera and the whole of the species are considered by him to be extinct. Mr. De Vis remarks:—"The extent of the change which the Nototherian avifauna of Queensland is thus shown to have undergone is very much the same as that observed in the case of the marsupials. With two or three *very doubtful* exceptions, all these have submitted to specific metamorphosis, and of twenty-six of the old genera but fourteen survive. Has the change been rapid? Then, from what cause? Not from the advent of man; savages do not exterminate. Have we hitherto considered this fauna younger than it really was? Possibly; but for the solution of these questions we must look to further accumulation and study of palæontological evidence. So far as the Writer can see at present, the Age of the fauna preserved in the Darling Downs Deposits cannot well be later than Early Pliocene."

### Order—CARINATÆ.

#### Family—FALCONIDÆ.

*Genus*—*TAPHÆTUS*, *De Vis*, 1891.

(*Proc. Linn. Soc. N. S. Wales*, vi. (2), p. 123.)

*TAPHÆTUS BRACHIALIS*, *De Vis*.

*Uroctus brachialis*, *De Vis*, *Loc. cit.*, 1889, v. (2), Pt. 4, p. 162.

*Taphætus brachialis*, *De Vis*, *Loc. cit.*, 1891, vi. (2), Pt. 1, p. 123.

*Obs.* The distal half of a humerus and a femur of a diurnal bird of prey are recorded under the above names respectively, given in the synonymy. The humerus was "the first relic of an arboreal bird of flight hitherto recognised amongst the remains of the extinct birds of Queensland." The femur, on which Mr. De Vis appears to lay the greatest stress, is compared with that of several living genera, and the following description offered:—"Femur stout (index circ. 9-4), proximal end transversely expanded, shaft compressed, pneumatic foramen small; a rudimentary third trochanter, entepicondylar pit between condyle and epicondyle."

*Loc. and Horizon.* King's Creek, Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.); Neighbourhood of Warwick, Darling Downs (*H. Hurst*—Colln. Queensland Mus.)

\* *Proc. Linn. Soc. N. S. Wales*, 1892, vi. (2), Pt. 3, p. 455.

*Genus—NECRASTUR, De Vis, 1892.*

(Proc. Linn. Soc. N. S. Wales, vi. (2), Pt. 3, p. 437.)

*NECRASTUR ALACER, De Vis.**Necrastur alacer*, De Vis, *Loc. cit.*, p. 437, t. 24, f. 1a and b.*Obs.* Portion of the proximal end of a right humerus, and the distal end of an ulna representing a bird allied to *Nisætus*, the Little-crested Eagle.*Loc.* Darling Downs (C. W. De Vis—Colln. Queensland Mus.)

## Family—PELICANIDÆ.

*Genus—PELICANUS, Linnæus, 1748.*

(Syst. Nat.)

*PELICANUS PROAVUS, De Vis.**Pelicanus proavus*, De Vis, Proc. Linn. Soc. N. S. Wales, 1892, vi. (2), p. 444, t. 24, f. 6a and b.*Obs.* A left tarsometatarsal and a mutilated metacarpal have been identified by Mr. De Vis as those of a small Pelican.*Loc.* Darling Downs (C. W. De Vis—Colln. Queensland Mus.)

## Family—ARDEIDÆ.

*Genus—PALÆOPELARGUS, De Vis, 1892.*

(Proc. Linn. Soc. N. S. Wales, vi. (2), Pt. 3, p. 441.)

*PALÆOPELARGUS NOBILIS, De Vis.**Palæopelargus nobilis*, De Vis, Proc. Linn. Soc. N. S. Wales, 1892, vi. (2), Pt. 3, p. 441, t. 24, f. 4a and b.*Obs.* The remains of this bird consist of the "distal end of a right 'medius' metacarpal in conjunction with that of the 'annularis.'"The metacarpals most nearly allied to *P. nobilis*, Mr. De Vis believes to be those of *Curphibis* and *Xenorhynchus*, and of these the latter approaches it most nearly in general form and size combined.*Loc.* Darling Downs (C. W. De Vis—Colln. Queensland Mus.)*Genus—PLATALEA, Linnæus, 1766.*

(Syst. Nat., Ed. xii.)

*PLATALEA SUBTENUIS, De Vis.**Platalea subtenuis*, De Vis, Proc. Linn. Soc. N. S. Wales, 1892, vi. (2), Pt. 3, p. 443, t. 24, f. 5a and b.*Obs.* Proximal two-thirds of a right femur of a supposed Spoonbill. "The specific differences from *P. regia* and *P. flavipes* observable in the fossil are a greater flattening of the proximal end of the shaft on its posterior surface, and a diminution of the transverse axis of its distal moiety, resulting in a more cylindrical but more slender form."*Loc.* Darling Downs (C. W. De Vis—Colln. Queensland Mus.)

## Family—ANATIDÆ.

Genus—*ANAS*, *Linnaeus*, 1748.

(Syst. Nat.)

*ANAS ELAPSA*, *De Vis*.*Anas elapsa*, De Vis, Proc. Linn. Soc. N. S. Wales, 1888, iii. (2), Pt. 3, p. 1281, t. 33, f. 4a-c.

*Obs.* The presence of *Anas* amongst the Post-Tertiary fossils of Queensland depends upon the identification of a left tibia and portion of a left femur by Mr. De Vis. The proportions and general appearance of the bones are those of a Teal, and the size about that of *Anas punctata*.

*Loc. and Horizon.* Chinchilla, Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Lacustrine or Fluvial deposits. ["The Chinchilla deposits are beds of sand of considerable but unascertained thickness . . . overlaid by a hard conglomerate of argillaceous grit and gravel . . . and evidently a lacustrine beach, or river bank detritus."—*De Vis*.]

Genus—*DENDROCYGNA*, *Swainson*, 1837.

(Nat. Hist. Birds, p. 365.)

*DENDROCYGNA VALIDIPINNIS*, *De Vis*.*Dendrocygna validipinnis*, De Vis, Proc. Linn. Soc. N. S. Wales, 1888, iii. (2), Pt. 3, p. 1282, t. 34, f. 5-6.

*Obs.* A Wood-duck is represented by the proximal half of a left humerus, and a right ulna. The bones cannot be identified, says Mr. De Vis, with either of the living Australian species.

*Loc. and Horizon.* Chinchilla, Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Chinchilla Conglomerate.

Genus—*BIZIURA*, *Leach*, 1824.

(Gen. Zoology.)

*BIZIURA EXHUMATA*, *De Vis*.*Biziura exhumata*, De Vis, Proc. R. Soc. Queensland, 1889, vi., Pt. 1, p. 57, t. 4.

*Obs.* The fossil to which this name is applied is the left metatarsus of a Duck, agreeing in its massive proportions with the existing genus *Biziura*. It is approximately two-thirds the size of the metatarsus of a male *Biziura lobata*, Shaw; if, therefore, from an individual of the same sex it would represent a smaller species, but if, on the other hand, from a female, a larger one.

*Loc. and Horizon.* Chinchilla, Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Chinchilla Conglomerate.

Genus—*NYROCA*, *Fleming*, 1822.

(Phil. Zool.)

*NYROCA ROBUSTA*, *De Vis*.*Nyroca robusta*, De Vis, Proc. Linn. Soc. N. S. Wales, 1888, iii. (2), Pt. 3, p. 1278, t. 33, f. 1 and 2.

*Obs.* This name was proposed for portions of a right humerus, ulna, and left coracoid, supposed to represent a *Nyroca* of superior strength to the White-eyed Duck (*N. australis*, Gould). "It was a distinctly larger species than its Australian representative in modern days, being one-eighth more in the width of the elbow-joint."

*Loc. and Horizon.* Chinchilla, Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Chinchilla Conglomerate.

**NYROCA RECLUSA, De Vis.**

*Nyroca australis et reclusa*, De Vis, Proc. Linn. Soc. N. S. Wales, 1888, iii. (2), Pt. 3, pp. 1281 and 1292, t. 33, f. 3.

*Obs.* A coracoid bone is referred to the recent species *N. australis*, Gould. "It is the first instance, within the Writer's personal experience, of identity, or even of affinity so close, between recent and post-pliocene vertebrates from Darling Downs." In a postscript, however, reasons are assigned for regarding it as distinct from *Nyroca australis*, and the specific name *reclusa* is given to it.

*Loc. and Horizon.* Chinchilla, Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Chinchilla Conglomerate.

**Family—PLOTIDÆ.**

**Genus—PLOTUS, Linnæus, 1766.**

(Syst. Nat., Ed. xii.)

**PLOTUS PARVUS, De Vis.**

*Plotus parvus*, De Vis, Proc. Linn. Soc. N. S. Wales, 1888, iii. (2), Pt. 3, p. 1286, t. 35, f. 10a and b.

*Obs.* A left humerus would appear to indicate the presence of a Darter, with certain affinities to the Pelicanidæ. "Together with the essential traits of *Plotus* this bone has, as we have seen, a few indications of extraneous affinity—perhaps we may infer that, as an early form of the genus, it had not attained the high specialisation of its later representative."

*Loc. and Horizon.* Chinchilla, Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Chinchilla Conglomerate.

**Family—COLUMBIDÆ.**

**Genus—LITHOPHAPS, De Vis, 1891.**

(Proc. Linn. Soc. N. S. Wales, vi. (2), Pt. 1, p. 121.)

**LITHOPHAPS ULNARIS, De Vis.**

*Lithophaps ulnaris*, De Vis, *Loc. cit.*, p. 122.

*Obs.* A genus and species founded on an ulna having the general proportions of the genus *Chalcophaps*. It is thus described—"Ulna stout, index 7-38, subcylindrical, continuously arched, with a single row of eight remigial tubercles; arthral surfaces as in *Megaloprepia*."

*Loc. and Horizon.* Neighbourhood of Warwick, Darling Downs (*H. Hurst*—Colln. Queensland Mus.)

**Family—GOURIDÆ.**

**Genus—PROGURA, De Vis, 1888.**

(Proc. R. Soc. Queensland, v., Pt. 4, p. 131.)

**PROGURA GALLINACEA, De Vis.**

*Progura gallinacea*, De Vis, *Loc. cit.*, p. 127, 2d. pl., 4 side figs.

*Obs.* The presence of a *Goura* or "Ground Pigeon" during Post-Tertiary times is indicated, according to Mr. De Vis, by four portions of metatarsals. Affinity with the genus *Goura* is "indicated by the shortness of the calcaneal process, sudden attenuation of the inner edge of the bone at its proximal end, elevation of the hind toe, rapid expansion of the distal end, and subsequent descent of the lateral trochleas." The fossils are twice the size of the corresponding bones of *Goura*.

*Loc. and Horizon.* Chinchilla and Gowrie Creek, Darling Downs\* (*C. W. De Vis*—Colln. Queensland Mus.)

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\* Information supplied by Mr. De Vis.

## Family—MEGAPODIDÆ.

Genus—*CHOSORNIS*, De Vis, 1889.

(Proc. R. Soc. Queensland, vi. Pt. 1, p. 55.)

*CHOSORNIS PRÆTERITUS*, De Vis.*Chosornis præteritus*, De Vis, Proc. R. Soc. Queensland, 1889, vi., Pt. 1, p. 55.

*Obs.* Mr. De Vis has proposed this species for the reception of the proximal half of the metacarpus of the left manus of a bird which agrees in several special points with those of the mound-building family. The bone combines features common to both the existing genera *Talegallus* and *Megapodius*, with others peculiar to itself.

*Loc. and Horizon.* Chinchilla, Darling Downs (C. W. De Vis—Colln. Queensland Mus.)—Chinchilla Conglomerate.

## Family—RALLIDÆ.

Genus—*PORPHYRIO*, Brisson, 1760.

(Ornithologie.)\*

*PORPHYRIO ? REPERTA*, De Vis.*Porphyrio reperta*, De Vis, Proc. Linn. Soc. N. S. Wales, 1888, iii. (2), Pt. 3, p. 1283, t. 34, f. 7 a and b.

*Obs.* A right tarso-metatarsus is referred provisionally by Mr. De Vis to a Coot, near *Porphyrio melanotus* in size. It may, however, be generally distinct.

*Loc. and Horizon.* Chinchilla, Darling Downs (C. W. De Vis—Colln. Queensland Mus.)—Chinchilla Conglomerate.

*PORPHYRIO MACKINTOSHI*, De Vis.*Porphyrio Mackintoshi*, De Vis, Proc. Linn. Soc. N. S. Wales, 1892, vi. (2), Pt. 3, p. 440, t. 24, f. 2 a and b.

*Obs.* The distal extremity of a right tarso-metatarsus indicates a species differing from the preceding in its greater size. Mr. De Vis remarks that probably the present species and *Porphyrio reperta* will require to be placed in a new genus, in consequence of the lesser elevation of the hind toe than in the recent forms of *Porphyrio*, whilst the inner trochlea in the present fossil is distinctly shorter.

*Loc. and Horizon.* Near Warwick (H. Hurst—Colln. Queensland Mus.)—Fluviatile deposits.

Genus—*GALLINULA*, Brisson, 1760.

(Ornithologie.)†

*GALLINULA STRENUIPES*, De Vis.*Gallinula strenuipes*, De Vis, Proc. Linn. Soc. N. S. Wales, 1888, iii. (2), Pt. 3, p. 1284, t. 34, f. 8, 8a.

*Obs.* A left tarso-metatarsus is described by Mr. De Vis under this name. It is a little less than one-fifth longer than the corresponding bone in *Gallinula tenebrosa*. "The evidence given may perhaps be held to show that the bird represented by this bone was a Moor-hen, and one of larger size than the living species."

*Loc. and Horizon.* Chinchilla, Darling Downs (C. W. De Vis—Colln. Queensland Mus.)—Chinchilla Conglomerate.

*GALLINULA PERALATA*, De Vis.*Gallinula peralata*, De Vis, Proc. Linn. Soc. N. S. Wales, 1892, vi. (2), Pt. 3, p. 440, t. 24, f. 3 a and b.

*Obs.* Founded on a humerus possessing an index so far raised as to indicate a bird of superior strength to the recent *G. tenebrosa*, or the extinct *G. strenuipes*.

*Loc. and Horizon.* Darling Downs (C. W. De Vis—Colln. Queensland Mus.)—Fluviatile deposits.

\* Fide Agassiz, Nomen. Zool., Fas. 2, p. 31.

† Agassiz, loc. cit., p. 30.

Genus—*TRIBONYX*, *Du Bus*, 1837.

(Bull. Acad. Brux.)

*TRIBONYX EFFLUXUS*, *De Vis*.*Fulica prior*, De Vis, Proc. Linn. Soc. N. S. Wales, 1883, iii. (2), Pt. 3, p. 1285, t. 35, f. 9b.*Tribonyx effluxus*, De Vis, *Ibid.*, 1892, vi. (2), Pt. 3, p. 439.

*Obs.* The distal end of a humerus was originally figured by Mr. De Vis as that of a *Fulica*, but it proves to be more properly referable to the above genus. In *Fulica*, *Gallinula*, and *Porphyrio*, the antero-interior side of the trochlea is emarginated, but in *Tribonyx* it is entire.

*Loc. and Horizon.* Chinchilla, Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Chinchilla Conglomerate.

Genus—*FULICA*, *Linnaeus*, 1748.

(Syst. Nat.)

*FULICA PRIOR*, *De Vis*.*Fulica prior*, De Vis, Proc. Linn. Soc. N. S. Wales, 1888, iii. (2), Pt. 3, p. 1258, t. 35, f. 9a (non f. 9b).

*Obs.* This name is now restricted, Mr. De Vis informs me, to the proximal end of a humerus, formerly associated under the same name with the distal end of another like bone.

*Loc. and Horizon.* Chinchilla, Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Chinchilla Conglomerate.

Family—*CICONIIDÆ*.Genus—*XENORHYNCHUS*, *Bonaparte*.*XENORHYNCHUS NANUS*, *De Vis*.*Xenorhynchus nanus*, De Vis, Proc. Linn. Soc. N. S. Wales, 1883, iii. (2), Pt. 3, p. 1287, t. 35, f. 11 a and b.

*Obs.* The distal half of a right tibia, which resembles that of the *Jabiru*.

*Loc. and Horizon.* Chinchilla, Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Chinchilla Conglomerate.

Order—*RATITÆ*.Family—*DROMORNITHIDÆ*.Genus—*DROMORNIS*, *Owen*, 1872.(Proc. Zool. Soc., 1872, p. 682; Trans. *Ibid.* 1873, viii., Pt. 4, p. 381.)*DROMORNIS AUSTRALIS*, *Owen*.*Dromornis Australis*, Owen, Proc. Zool. Soc., 1872, p. 682; *Ibid.*, 1887, Pt. 1, p. 95." " " Trans. *Ibid.*, 1873, viii., Pt. 4, p. 381, t. 62, t. 63, f. 1 and 2.*Dinornis Oweni*, Krefft (m.s.), Geol. Mag., 1874, i., p. 46 (note).*Dromornis Australis*, Etheridge fil., Cat. Australian Foss., 1878, p. 179 (for synonymy).

" " " Owen, Mem. Wingless Birds New Zealand, &amp;c., 1879, p. 467, t. 100, f. 1 and 2.

" " " Etheridge fil., Rec. Geol. Survey N. S. Wales, i., Pt. 2, 1889, p. 129, t. 11, f. 1 and 2, t. 12, f. 1 and 2; *Ibid.*, ii., Pt. 1, 1890, p. 36.

" " " Lydekker, Cat. Foss. Birds Brit. Mus., 1891, p. 355.

*Obs.* The first intimation of the occurrence of a Struthious Bird in the Post-Tertiary deposits of Queensland is due to the late Rev. W. B. Clarke, who announced \* the discovery, in 1869, of a femur twelve inches in length, found on sinking a well on the Peak Downs, between Lord's Table Mountain and the heads of Theresa Creek, and near the track from Clermont to Broadsound. The bone was found in a deposit of drift pebbles and boulders one hundred and fifty feet

\* Geol. Mag., 1869, vi., p. 383.

thick, overlaid by thirty feet of black trappean alluvium. Clarke referred the bone to *Dinornis*, but in 1872 Sir R. Owen fully described it as a new genus allied to *Dromæus*, under the name of *Dromornis* (*D. australis*, Owen). The remains of *Dromornis* are also known from New South Wales, for the mutilated femur from the Wellington Caves, figured by Prof. Owen in Mitchell's "Three Expeditions into the Interior of East Australia,"\* is regarded by him as identical with the Queensland bone. It is thirteen inches in length, and was considered by Prof. Owen, from comparative measurements, to represent a bird with a greater stature than the *Dinornis elephantopus*.

At the time Mr. Clarke made his announcement the late Mr. G. Krefft referred to the remains of this bird as a Moa, about the size of the *Dinornis robustus*. He says, "The specimen proving the presence of the gigantic bird, a large femur, was found on the Leichhardt Downs in Queensland, eighty-six feet below the surface, and is now in the Australian Museum."

A pelvis of *Dromornis* was subsequently found in the Canadian Gold Lead, near Gulgong, New South Wales, and a mutilated left tibia at Mount Gambier, South Australia,† both of which were examined, and the latter described by Sir Richard Owen.‡ His conclusions on the femur and tibia are the following:—

"The femur, in its essential character, resembles that of the Emu more than it does the similar bone of the Moa," and that "the characters in which it more resembles *Dinornis* are concomitant with, and related to, the more general strength and robustness of the bone—from which we may infer that the species manifested dinornithic strength and proportions of the hind limbs, combined with the characters of close affinity to the existing smaller, more slender-limbed, and swifter wingless bird peculiar to the Australian continent."§

With regard to the tibia, it need be only stated that there is a nearer resemblance "as in the femur of the gigantic wingless bird of Australia to the genera still there represented (*Dromaius* and *Casuarina*) than to *Dinornis*, *Apteryx*, or *Struthio*."||

In 1889, amongst a collection of bones received at the Geological and Mining Museum, Sydney, from Mr. A. S. Cotter, several fragments of bird bones were recognised. The specimens were obtained at a depth of twenty feet from the surface in sinking a well on Caiwarroo Station, near Thargomindah, on the Paroo River. The bird bones consist of portions of the right tibia and left fibula of *Dromornis*, and part of the right tibia of a *Dromaius*.

The *Dromornis* tibia is the distal extremity of the right bone, obliquely broken as near as possible about the middle of the shaft. The comparative measurements agree fairly well with those of Professor Owen, bearing in mind the relative state of preservation of the bones.

Measurements.	Owen's <i>Dromornis</i> .		Paroo <i>Dromornis</i> .	
	Inches.	Lines.	Inches.	Lines.
Transverse breadth of the shaft at the commencement of the distal expansion	2	2	2	1½
Transverse breadth of the shaft at the commencement of the distal condyles	3	5	3	0

\* 2 Vols. 8vo., London, 1838.

† Trans. Zool. Soc., 1877, x., Pt. 3, p. 186.

‡ For a full history of these discoveries see Clarke, *loc. cit.*

§ Trans. Zool. Soc., 1873, viii., Pt. 6, p. 383.

|| *Ibid.*, 1877, x., Pt. 3, No. 8, p. 187. Mr. De Vis informs me that he does not concur in Owen's view of the affinities of *Dromornis*.

The bone as preserved is eight and a-quarter inches long, the broken proximal end of the shaft having a diameter of one and eleven-sixteenths inches, with a round oval section. A measurement taken across the precondylar groove, at that point which in *Dinornis* would be occupied by the bony bridge, gives two and six-sixteenths inches. The anterior surface of the shaft at its proximal end is flattened to some extent, but the posterior is much more convex. The inner lateral surface is also flattened, or may be described as straight-walled, and is margined anteally by an extension of the distal extremity of the pronemial ridge, which is prominent but obtuse. On the anterior surface, the most noticeable feature is the precondylar groove, which is traceable from within two and a-half inches of the broken proximal end of the shaft. The shallow proximal end of this groove is quite contiguous to the inner lateral margin of the shaft, but, as it progresses towards the forepart of the bone, it takes up a median position, as described by Owen. The fossa, or deeper portion between the commencement of the condyles, is more transversely obliquely placed and more open than in the latter's figure of the left tibia. Its foramen is very much larger than the corresponding pit in the right tibia of *Dinornis crassus*; and at the same time there is a most marked difference between the fore and aft thickness of this bone immediately above the position of the bony bridge and that in the first cited. In *Dinornis crassus* it is one and two-sixteenths inches, but in our *Dromornis* the measurement reaches one and six-sixteenths inches—i.e., a difference of a quarter of an inch. When the distal pulley-like articular surface is compared with that of *Dinornis crassus*, very marked differences are perceptible. The inner and upper ends of the condylar ridge on the anterior side approximate closely in *Dinornis*, but they do not do so in *Dinornis crassus*, the result being that the intercondylar space or channel is much narrower throughout the whole of its course in *Dromornis* than in *Dinornis crassus*. On the outer lateral surface, between the upper edges of the anterior and posterior condylar margins, there is an almost median depression; this also exists in *Dinornis*. On the contrary, in the Emu and in the Cassowary this is not present, but the surface of the bone is plain and flattened. The bone-substance is thick, measuring at the proximal fracture six-sixteenths of an inch, the central cavity being one inch in diameter, and somewhat less in a contrary direction.

The bone which I refer to the fibula, is in the same state of preservation. It is the proximal end of the left bone, three and a-quarter inches long. The upper articular surface is worn and almost flat and broad; in fact much broader than in the corresponding portion of the fibula of *Dinornis elephantopus*. The outer edge of the head is sharp, and the same side retires inwards, forming a strongly concave surface. The fore and aft measurement of the head is two and fourteen-sixteenths inches, the transverse or cross measurement being one and three-quarter inches. The inner side of the fibula in *Dinornis elephantopus*, between the two inner extremities of the head, is roughly triangularly concave; in the Emu it is elongately concave, but in the present fossil the similar surface is limited, to some extent protuberant, and deeply and closely marked by pits for muscular attachment.

The posterior prolongation of the head is very marked and long, projecting backwards as an obtuse elongate process, and when compared with the similar part of the fibula of *D. elephantopus*, is at once seen to be less thick and massive but more projecting. In the Ostrich there is a further diminution, and a still greater in the Emu. The diameter of the shaft of the fibula in the *Dinornis elephantopus* is one and four-sixteenths inches at a corresponding point to that at which our bone is broken. The same measurement of the latter is only one inch, proving it to be a less powerful bone



at this particular point. The antero-posterior width of the present fossil at the fractured end is one and thirteen-sixteenths inches; that of the bird used above for comparison nearly as possible the same.

The first point which strikes one is the generally more massive outline of this fibula than that of *Dinornis*, especially in the wider and larger head. The next peculiarity is the outer and concave smooth surface under the head, which is noticeably different to the structure of the bone both in *D. elephantopus* and the Emu.

*Loc. and Horizon.* Peak Downs between Lord's Tableland and the head of Theresa Creek (*The late Rev. W. B. Clarke*—Colln. Australian Mus.); Caiwaroo Station, near Thargomindah, Paroo River (*A. S. Cotter*—Colln. Mining and Geol. Mus., Sydney)—Fluviatile deposits.

#### Family—CASUARIIDÆ.

#### Genus—*DROMAIUS*, Vieillot, 1816.

(Analyse Nouv. Ornith. Élément.) \*

#### *DROMAIUS PATRICIUS*, De Vis.

*Dromaius novæ-hollandiæ*, Davies, Geol. Mag., 1884, i. (3), p. 265.

„ *patricius*, De Vis, Proc. Linn. Soc. N. S. Wales, 1888, iii., Pt. 3, t. 36, figs. 13a-c.

„ „ Etheridge fil., Rec. Geol. Survey N. S. Wales, i., Pt. 2, 1889, p. 132, t. 11, f. 4, t. 12, f. 3, t. 13, f. 3; *Ibid.*, ii., Pt. 1, 1890, p. 36.

*Dromæus patricius*, Lydekker, Cat. Foss. Birds Brit. Mus., 1891, p. 352.

*Dromaius patricius*, De Vis, Proc. Linn. Soc. N. S. Wales, 1892, vi. (2), Pt. 3, p. 446.

*Obs.* Under this name Mr. De Vis has described the proximal and distal ends of a right tibia, and a left coracoid, which appear to be distinct from the living Emu (*Dromaius novæ-hollandiæ*).

Associated with the remains of *Dromornis* from the Paroo we have the distal end of a right tibia, which is clearly identical with that of *Dromaius patricius*, and is probably that of a full-grown bird. Chief amongst the many points of interest is the great development of the extreme distal end of the shaft, where broken, as compared with the condylar portions. That is to say—in the fossil tibia the shaft is much the larger and more solid, but in the recent bone the condyles and portions contiguous are by far the more massive. In the former the cavity of the shaft is fourteen-sixteenths of an inch by eight-sixteenths of an inch, but in the latter these measurements are reduced to twelve-sixteenths and seven-sixteenths respectively. In both the thickness of the bone is the same, two-sixteenths of an inch. The marked difference in the size of the two bones appears to have also struck Mr. De Vis, and is expressed in his description of the distal end of the tibia.

Mr. R. Lydekker ascribes my specimen to New South Wales, but the locality whence it is derived is in Queensland.

*Loc. and Horizon.* King's Creek, Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.); Caiwaroo Station, near Thargomindah, Paroo River (*A. S. Cotter*—Colln. Mining and Geol. Mus., Sydney)—Fluviatile deposits.

#### *DROMAIUS GRACILIPES*, De Vis.

*Dromaius gracilipes*, De Vis, Proc. Linn. Soc. N. S. Wales, 1892, vi. (2), p. 445, t. 23, f. 7a-b.

*Obs.* The distal extremity of a metatarsus smaller and slimmer than that of the living *D. novæ-hollandiæ*, has prompted the establishment of the present species; nor does any trace of the plantar artery canal, or of the tunnel or groove for the descending branch of the artery exist. The above species, *D. patricius*, is intermediate

\* Fide Agassiz, Nomen. Zool., Fas. 2, p. 26.

in the latter characters, the plantar perforation being exceedingly small; not greater than the diameter of an ordinary pin. In all probability *D. gracilipes* was not only smaller than the Emu, but also more attenuated in the proportions of its limb.

*Loc. and Horizon.* Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Fluviatile deposits.

### Family—DINORNITHIDÆ.

*Genus*—*DINORNIS*, Owen, 1844.

(Trans. Zool. Soc., iii., Pt. 3, 235.)

*DINORNIS QUEENSLANDIÆ*, *De Vis*.

*Dinornis queenslandiæ*, De Vis, Proc. R. Soc. Queensland, 1884, i., Pt. 1, p. 23, t. 3 and 4.

" " Lydekker Cat. Foss. Birds Brit. Mus., 1891, p. 222.

" " De Vis, New Zealand Journ. Sci., 1891, i. (2), No. 3, p. 97.

*Obs.* The presence of a species of Moa during Post-Tertiary times in Queensland has been inferred by Mr. C. W. De Vis from the characters of a struthious femur in the Queensland Museum. The specimen presents precisely the measurements of *Dinornis crassus*, Owen, and Mr. De Vis adds—"The large air channel into the interior bone of the Emu, so intimately connected with the excursive habits of the typical birds, is wanting in all the fossils under consideration, but in the Moa, and in our fossil alike, it is foreshadowed by three small foramina just beneath the hinder edge of the neck. . . . The chief particulars in which the femur differs from that of *Dromornis*, are a long sloping neck, constricted at its junction with the head, a full and irregularly oval shaft, and a broad outer trochanterian surface. These are precisely the characters by which the corresponding part of the thigh-bone of *Dinornis* is differentiated by Sir R. Owen from that of *Dromornis*, and in all of them our fossil agrees almost exactly with the femurs of *D. crassus* and *D. elephantopus*."

I am indebted to the courtesy of Mr. De Vis for a reproduction of this fragmentary bone. A very careful comparison with the femur of a *Dinornis* and with the type of *Dromornis* compels me to admit the close resemblance between his bone and the former. On it Mr. R. Lydekker also remarks—"This specimen appears indistinguishable from the femora of true Dinornithidæ, and is quite different from the femur of *Dromornis*."

*Loc. and Horizon.* King's Creek, Darling Downs (*J. Daniels*—Colln. Queensland Mus.)—Fluviatile deposits.

### Family—APTERYGIDÆ.

*Genus*—*METAPTERYX*, *De Vis*, 1892.

(Proc. Linn. Soc. N. S. Wales, vi. (2), Pt. 3, p. 453.)

*METAPTERYX BIFRONS*, *De Vis*.

*Metapteryx bifrons*, De Vis, *Loc. cit.*, p. 453, t. 23, f. 8 a and b.

*Obs.* The distal half of a tarso-metatarsus, on careful comparison with the similar bone in the *Apteryx*, seems to "justify the conclusion that in spite of all our preconceptions this Australian relic represents a bird having a decided family relationship with the Apterygidæ of New Zealand." The more striking features in which it appears to resemble the *Apteryx* are the great distal extension of the pedicels of the trochleæ, a like equality in the length of the opposed surfaces of the lateral pedicels, and the extension of the mesial trochleæ beyond the extremities of the other two, &c. It is, however, not an *Apteryx*, as is evinced by the absence or rudimentary state of the hind toe, the

superior length of the inner one of the lateral toes, and the enlargement of the middle one out of all proportion to the laterals. Although *M. bifrons* did not exceed the living Kiwis in stature, its cursorial power was much greater, and it may be inferred that the bird was as much an Emu as an *Apteryx*.

*Loc. and Horizon.* Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Fluviatile deposits.

## Class—MAMMALIA.

### Order—MONOTREMATA.

#### Family—ECHIDNIDÆ.

#### *Genus*—*ECHIDNA*, Cuvier, 1797.

(Tabl. Élémentaire, p. 143.)

#### *ECHIDNA OWENII*, Krefft.

*Echidna Owenii*, Krefft, Ann. and Mag. Nat. Hist., 1868, i., p. 113, f. 1-5.

" " Krefft, Australian Vert. Fossil and Recent, 1871, p. 22.

" *Ramsayi*, Owen, Phil. Trans., 1884, clxxx., Pt. 1, p. 273, t. 14.

" *Owenii*, Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 295.

*Obs.* The late Mr. G. Krefft figured a fragment of a humerus of larger size than the corresponding bone of the existing *Echidna*, to which he applied the above name.

Sir Richard Owen has since described the remains of an *Echidna* from the Wellington Valley Caves as *E. Ramsayi*, but he made no comparison between his own and Mr. Krefft's fossils. It is, however, probable that Mr. Richard Lydekker is correct in uniting both in one species. He remarks—"Considerably exceeding in size the existing *E. Bruinii* of New Guinea." Sir Richard Owen's type was obtained in the ossiferous breccia of the Wellington Caves.

*Loc. and Horizon.* Darling Downs (*The late G. Krefft*—Colln. Australian Museum)—Fluviatile deposits.

#### Family—ORNITHORHYNCHIDÆ.

#### *Genus*—*ORNITHORHYNCHUS*, Blumenbach, 1800.

(Voigt's Magazin.)\*

#### *ORNITHORHYNCHUS AGILIS*, De Vis.

*Ornithorhynchus agilis*, De Vis, Proc. R. Soc. Queensland, 1885, ii., Pt. 1, p. 35, t. 4, f. 1-3.

*Obs.* The existence of the Platypus in Post-Tertiary times in Queensland is believed by Mr. De Vis to be assured from the presence of an adult right tibia. "It shows no sign of having been inherited from a less modified, that is, more reptilian precursor; on the contrary, it possesses all the character of the genus as represented by [*O.*] *paradoxus*, fully matured, and even more pronounced than in its descendant. It is, perhaps, worthy of remark that, presuming this tibia to be full-sized as well as adult, it indicates a species of smaller dimensions than the present one." The bone is even thought to represent a distinct and undescribed genus.

A mandible was also collected at the same locality which corresponds in representing a smaller species than the living *O. anatinus*.

Messrs. Flower and Lydekker appear to have entirely overlooked the occurrence of this extinct species in their otherwise excellent account of the "Duck-billed Platypus."†

*Loc. and Horizon.* Near Pilton, King's Creek, Darling Downs (*C. W. De Vis*—Colln. Queensland Museum)—Fluviatile deposits.

\* *Fide* Agassiz, Nomenclator Zool., Fas. 1, p. 23.

† *Introductio*. Study of Mammals, Living and Extinct, 1891, p. 119.

## Order—MARSUPIALIA.

## Family—PHASCOLOMYIDÆ.

Genus—*PHASCOLOMYS*, *Geoffroy*, 1803.

(Ann. Mus. Hist. Nat. Paris, ii., p. 365.)

*Obs.* The extinct Wombats may be divided, as they have been to a certain extent by Sir R. Owen, into two groups—those of equal or less size than the existing species, and those exceeding the latter. In the first division we have *P. medius*, *P. magnus*, and *P. gigas*; in the second one, *P. Mitchelli*, *P. parvus*, *P. platyrhinus*, and *P. Thomsoni*. Professor Owen states that we are now acquainted with species of *Phascolomys* exhibiting “gradations of bulk rising from that of a Marmot to that of a Tapir;” but it is quite open to doubt if the gigantic species burrowed, like their more recent and smaller brethren.

*PHASCOLOMYS MEDIUS*, *Owen*.

- Phascolomys medius*, Owen, Phil. Trans., 1873, clxii., Pt. 2, p. 241, t. 32, f. 2-7, t. 33, f. 2-6, t. 34, t. 35, f. 7.  
 „ „ Owen, Extinct Mam. Australia, 1877, pp. 339 and 353, Atlas, t. 57, f. 2-7, t. 58, f. 2-6, t. 59, t. 60, f. 7.  
 „ „ Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 149.

*Obs.* Lower and upper jaws of this species have been discovered, indicating a Wombat larger than either of the two largest existing species. The lower jaw must have been six or seven inches in length, and the entire animal when full grown one-half larger than *P. platyrhinus*.

*Loc. and Horizon.* Condamine River at Eton Vale, Darling Downs (*E. S. Hill*—Colln. Brit. Mus.); King's Creek, Darling Downs (*Mr. Turner*—Colln. Brit. Mus.); Drayton, Darling Downs (*Sir D. Cooper*—Colln. Brit. Mus.)—Fluviatile deposits.

*PHASCOLOMYS MAGNUS*, *Owen*.

- Phascolomys magnus*, Owen, Phil. Trans., 1873, clxii., Pt. 2, p. 246, t. 35, f. 1-6.  
 „ „ Owen, Extinct Mam. Australia, 1877, pp. 344-346, and 353, t. 60, f. 1-6.  
 „ „ Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 148.

*Obs.* The disposition of the upper molars in this species resembles that of *P. medius*, and is of the type of the existing Hairy-nosed Wombat.

*Loc. and Horizon.* Eton Vale, Darling Downs (*E. S. Hill*—Colln. Brit. Mus.); Drayton, Darling Downs (*Sir D. Cooper*—Colln. Brit. Mus.)—Fluviatile deposits.

*PHASCOLOMYS MITCHELLI*, *Owen*.

- Phascolomys Mitchelli*, Owen, Mitchell's Three Exped. Int. E. Australia, 1838, ii., p. 362, t. 30, f. 4-6.  
 „ „ Owen, Phil. Trans., 1873, clxii., Pt. 2, pp. 177, 179, 181, 182, and 191, t. 17, f. 1, 3-5, 7 and 8, t. 18, f. 1-7, t. 19, f. 5, t. 21, f. 5 and 6.  
 „ „ Owen, Extinct Mam. Australia, 1877, pp. 318, 320, 322, 324, 333, and 353, t. 50, f. 1, 3, 5, 7, and 8, t. 51, f. 1-7, t. 53, f. 5, t. 55, f. 5 and 6.  
 „ „ Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 152.  
 „ „ De Vis, Proc. Linn. Soc. N. S. Wales, 1891, vi. (2), Pt. 2, p. 239.

*Obs.* This species agrees more or less in size with the existing Wombats, and is close to *P. platyrhinus*. Mr. C. W. De Vis has quite recently afforded strong evidence of the satisfactory specific importance of this species, by describing numerous bones other than those of the cranium.

*Loc. and Horizon.* Gowrie, Darling Downs (*F. N. Isaacs*)—Fluviatile deposits.

## PHASCOLOMYS PARVUS, Owen.

*Phascolomys parvus*, Owen, Phil. Trans., 1873, clxii., Pt. 2, p. 193, t. 19, f. 6 and 7, t. 20, f. 6-8, t. 23, f. 6 and 7, t. 38, f. 5 and 6.

" " Owen, Extinct Mam. Australia, 1877, pp. 334 and 353, Atlas, t. 53, f. 6 and 7, t. 54, f. 6-8, t. 56, f. 6 and 7, t. 63, f. 5 and 6.

" " Lydekker, Cat. Foss. Main. Brit. Mus., 1887, Pt. 5, p. 156.

*Obs.* Although a small species, does not agree with the smallest known living form, the Tasmanian Wombat.

*Loc. and Horizon.* King's Creek, Darling Downs (Mr. Turner—Colln. Brit. Mus.)—Fluviatile deposits.

## PHASCOLOMYS PLATYRHINUS, Owen.

*Phascolomys platyrhinus*, Owen, Phil. Trans., 1873, clxii., Pt. 2, pp. 175, 180, 193, t. 19, f. 2, t. 20, f. 3-5, t. 21, f. 2, t. 23, f. 1 and 8—cuts p. 175, f. 1, p. 179, f. 5, and p. 180, f. 7.

" " Owen, Extinct Mam. Australia, 1877, pp. 328-334, and 353—cuts p. 316, f. 3, p. 320, f. 5, p. 321, f. 7, t. 52, f. 2, t. 53, f. 2, t. 54, f. 3-5, t. 55, f. 2, t. 56, f. 1 and 8, t. 58, f. 1, t. 98, f. 3, 4, and 13, t. 99, f. 3 and 4, t. 100, f. 4-6 and 8, t. 101, f. 3, 4, and 10, t. 102, f. 2, 4, and 6.

" " Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 155.

*Obs.* The shape and proportions of the molars seen in the living examples of this species, says Prof. Owen, are closely preserved in the fossil forms. The researches of Mr. C. W. De Vis \* amongst the Darling Downs Phascolomydæ have rendered it exceedingly doubtful if this species is represented in the ossiferous deposits of that district, the remains hitherto ascribed to *P. platyrhinus* being in all probability those of *P. Mitchelli*.

*Loc. and Horizon.* Eton Vale, Darling Downs (E. S. Hill—Colln. Brit. Mus.)—Fluviatile deposits.

## PHASCOLOMYS THOMSONI, Owen.

*Phascolomys Thomsoni*, Owen, Phil. Trans., 1873, clxii., Pt. 2, p. 192, t. 18, f. 8 and 9, t. 21, f. 7.

" " Owen, Extinct Mam. Australia, 1877, pp. 333 and 353, t. 51, f. 8 and 9, t. 55, f. 7.

" " Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 156.

*Obs.* The critical examination of the Darling Downs fossil Wombat remains, already referred to, has led Mr. De Vis to the conclusion that this supposed species has no existence. He remarks †—" *P. Thomsoni*, Ow., is an extremely doubtful species, uniquely represented, and dependent for its validity upon a single character, the backward extension of the symphysis, a character which varies with age. . . . *P. Thomsoni* should, therefore, be expunged from our lists."

*Loc. and Horizon.* Drayton, Darling Downs (Sir D. Cooper—Colln. Brit. Mus.)—Fluviatile deposits.

## PHASCOLOMYS ANGUSTIDENS, De Vis.

*Phascolomys angustidens*, De Vis, Proc. Linn. Soc. N. S. Wales, 1891, vi. (2), Pt. 2, p. 243.

*Obs.* Established by Mr. De Vis for a Wombat distinguished by the narrowness of its teeth, "which are intermediate in breadth between those of *P. parvus* and *P. Mitchelli*, though serially as long or longer than in the latter species. As a marked reduction in the width of the teeth has not been noted in the descriptions of known species, and as the teeth in all the mandibles of *P. Mitchelli* are appreciably the same in width, I must perforce regard this narrow-toothed wombat as a new species." A humerus and a tibia are also referred to *P. angustidens*. The animal is supposed to have been equal in size to *P. Mitchelli*, but more delicate in structure.

*Loc. and Horizon.* Valley of the Condamine, Darling Downs (C. W. De Vis—Colln. Queensland Mus.)—Fluviatile deposits.

\* Proc. Linn. Soc. N. S. Wales, 1891, vi. (2), Pt. 2, p. 239.

† Loc. cit., p. 239.

Genus—*PHASCOLONUS*, Owen, 1872.

(Phil. Trans., clxii., p. 248.)

*PHASCOLONUS GIGAS*, Owen.*Phascolomys gigas*, Owen, Encyclop. Brit., 1859, xvii., p. 175, f. 114.,, (*Phascolonus*) *gigas*, Owen, Phil. Trans., 1873, clxii., Pt. 2, pp. 248 and 255, t. 36-38, f. 1, 3, and 4, t. 39, f. 1-3, t. 40.

,, ,, Owen, Extinct Mam. Australia, 1877, p. 346, t. 61-63, f. 1, 3, and 4, t. 64, f. 1-3, t. 65.

*Phascolonus gigas* (pars.), Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 157.

,, ,, De Vis, Proc. Linn. Soc. N. S. Wales, 1891, vi. (2), Pt. 2, p. 237.

*Obs.* For this gigantic Wombat, equalling as it did the Wild Ass in size, Prof. Owen has proposed the sub-generic name of *Phascolonus*, but both Mr. Lydekker and Mr. C. W. De Vis have raised it to generic rank.

*Loc. and Horizon.* King's Creek, Darling Downs (*The late C. H. Hartmann*—Colln. Brit. Mus.); Gowrie, Darling Downs (*Sir D. Cooper*—Colln. Brit. Mus.); Eton Vale, Darling Downs (*E. S. Hill*—Colln. Brit. Mus.); Tributary of the Condamine River, St. Jean Station (*S. St. Jean*—Colln. Australian Mus.); Clifton Plains, Darling Downs (*Sir F. Nicholson*—Colln. Queen's College, Cork)—Fluviatile deposits.

## Family—NOTOTHERIIDÆ.

Genus—*NOTOTHERIUM*, Owen, 1845.

(Brit. Assoc. Report for 1844, p. 231.)

*Obs.* *Nototherium* is second only in bulk to *Diprotodon*. The skull of the former is shorter in proportion to its breadth and depth than that of the latter. *Nototherium* resembles the Koala and Wombats, whilst *Diprotodon* is more nearly allied in many of its characters to the Kangaroos.\* *Nototherium* does not possess incisors of the relative size and shape and persistent growth characteristic of *Diprotodon*, but it surpasses the latter in both absolute and relative size of the zygomatic arches.

The dental formula of *Nototherium* is  $i: \frac{3-3}{1-1}, c: \frac{0-0}{0-0}, m: \frac{8-8}{8-8} = 28$ .

By some Authors *Zygomaturus*, Macleay, is considered as distinct from *Nototherium*, but Sir R. Owen believes them to be identical. Recently Mr. De Vis has revived this question,† and arrives at the following conclusions:—1st. That the upper premolar of *Nototherium* shows a departure not more than generic from that of *Diprotodon*, and consequently that both genera belong to one family, the Nototheriidae, which also includes *Euowenia*, and perhaps *Sthenomerus*. 2nd. That *Zygomaturus* is a good genus, and its affinity with the Nototheriidae is, to say the least, doubtful. 3rd. The mandibular structure and dentition of *Zygomaturus* are, as yet, unknown, as it was one of the rarer animals of its day, the paucity of its remains contrasting strongly with the abundance of those of *Nototherium*. These conclusions have been combated by Mr. R. Lydekker,‡ who regards the previous determination of Owen, that *Nototherium* and *Zygomaturus* are one and the same, as correct.

Mr. De Vis has also described a humerus which he ascribes to *Nototherium*.§

\* Mr. De Vis informs me that he considers that this view is by no means favoured by the pelvis and foot-bones, which are essentially phascolomine. Notwithstanding its molar system *Diprotodon* is far more a Wombat than a Kangaroo.

† Note on the Genera *Zygomaturus* and *Nototherium*. Proc. R. Soc. Queensland, 1888, v., Pt. 3, p. 111.

‡ Ann. and Mag. Nat. Hist., 1889, iii., p. 149.

§ Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 3, p. 404.

## NOTOTHERIUM MITCHELLI, Owen.

*Nototherium Mitchellii*, Owen, Brit. Assoc. Report for 1844 [1845], p. 232.

- " " Owen, Phil. Trans., 1872, clxii., Pt. 1, pp. 41, 52, 60, 66, and 82, t. 2, f. 1 and 2, t. 3, f. 1-3, t. 4, 5, and 6, t. 9, f. 1-4, 6-8, t. 10, f. 1-3, 7 and 8, t. 11, p. 42, f. 1, p. 61, f. 2.
- " " Owen, Extinct Mam. Australia, 1877, pp. 249, 272, 514, t. 36, f. 1 and 2, t. 37, f. 1-3, tt. 38, 39, 40, t. 43, f. 1-4, 6-8, t. 44, f. 1-3, 7 and 8, t. 45, t. 88, f. 11-14, p. 250, f. 1, p. 269, f. 2.
- " " Owen, Quart. Journ. Geol. Soc., 1882, xxxviii., p. 394, t. 16.
- " " (pars.), Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 163.

*Obs.* The skull, without a lower jaw attached, from King's Creek, presented to the Australian Museum by Mr. F. N. Isaac, and upon which Mr. Macleay established his genus *Zygomaturus*, Prof. Owen says, belongs to the same species as the lower jaw originally described by him from the same locality as *Nototherium Mitchellii*. The latter is now in the British Museum, and was purchased after being sent to London by Mr. Boyd.

*Loc. and Horizon.* King's Creek, Darling Downs (Restored Skull—Colln. Brit. and Australian Mus.); Eton Vale, Darling Downs (*E. S. Hill*—Colln. Brit. Mus.); Gowrie Creek, Darling Downs (*H. Hughes*—Colln. Worcester Nat. Hist. Soc.); Albert River (*R. Daintree*—Colln. Brit. Mus.); Warra Warra Station, Condamine River (*Dr. G. Bennett*—Colln. Brit. Mus.)—Fluviatile deposits.

## NOTOTHERIUM INERME, Owen.

*Nototherium inermis*, Owen, Brit. Assoc. Report for 1844 [1845], p. 231.

- " " Owen, Phil. Trans., 1872, clxii., Pt. 1, pp. 41, 43, and 67, t. 8, t. 9, f. 5.
- " " Owen, Extinct Mam. Australia, 1877, pp. 271 and 514, t. 42, t. 43, f. 5, t. 88, f. 15-17, t. 125.

*Obs.* The specific difference of *N. inermis* from the other two species of the genus is shown in the relative position of the symphysis to the fully-developed molar series. The name refers to the absence of incisor tusks.

Mr. Lydekker includes both this species and *N. victoriae*, Owen, as synonyms of *N. Mitchellii*.\*

*Loc. and Horizon.* Gowrie, Darling Downs (*G. F. Bennett*—Colln. Brit. Mus.)—Fluviatile deposits.

## NOTOTHERIUM DUNENSE, De Vis.

*Nototherium dunense*, De Vis., Proc. Linn. Soc. N. S. Wales, 1887, ii. (2), Pt. 4, p. 1065, t. 38.

- " " De Vis, Proc. R. Soc. Queensland, 1888, v., Pt. 3, p. 116, 2nd Pl., centre figs.

*Obs.* A mandibular fragment and a left adult mandible have been separated by Mr. De Vis as representing another species of *Nototherium*. It is distinguished from *N. Mitchellii*, Owen, "by the size and structure of the premolar and position of the inlet of the dental canal"; from *N. inermis*, Owen, "by the development of the tusks and consequent retrocession of the symphyseal curve"; and from *D. Victoriae*, Owen, "by the position of the inlet of the dental canal and by the gradual enlargement of the molars serially."

*Loc. and Horizon.* Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Fluviatile deposits.

\* Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 162.

*Genus—DIPROTODON, Owen, 1838.*

(Mitchell's Three Exped. Int. E. Australia, ii., p. 362.)

*DIPROTODON AUSTRALIS, Owen.**Diprotodon australis*, Owen, *Loc. cit.*, p. 362, t. 31, f. 1 and 2.*Mastodontoid Pachyderm*, Owen, *Ann. and Mag. Nat. Hist.*, 1843, xi., pp. 8 and 9, f. 2 and 3 (*non f. 1*).*Dinotherium australe*, Owen, *Ibid.*, p. 329, f. 1, p. 330, f. 2.*Diprotodon australis*, Owen, *Brit. Assoc. Report for 1844* [1845], p. 224." " Owen, *Phil. Trans.*, 1870, clx., Pt. 2, p. 519, t. 35, f. 1-4, t. 36-39, t. 40, f. 1-13, 16-18, t. 41-50." " Owen, *Extinct Mam. Australia*, 1877, pp. 189 and 507, t. 19, f. 1-4, t. 20, 23, and 24, f. 1-13, 16-18, t. 25-35, t. 122, f. 1-3, 7-10, t. 123 and 124, and frontispiece—cuts, f. 1 and 1a, p. 189, f. 2, p. 204, f. 5, p. 212, f. 6, p. 219." " Etheridge fil., *Cat. Australian Foss.*, 1878, p. 180 (*for full synonymy*).

*Obs.* *Diprotodon* combines the characters of the genera *Macropus* and *Phascodomys*, but with special modifications of its own, more particularly exhibited in the bones of the trunk and limbs. The pelvis and femora present resemblances to the Proboscidae not hitherto observed in any other remains of large extinct quadrupeds in Australia. In all the bones, however, essentially marsupial characters are visible.

The dental formula is  $i. \frac{2-3}{1-1}, c. \frac{0-0}{0-0}, m. \frac{5-5}{5-5} = 28$ .\*

Sir Richard Owen has recorded twenty-one occasions on which the remains of this large marsupial have been found throughout Australia †; of these discoveries no less than thirteen refer to Queensland, viz. :—

1. Tributaries of the Condamine River in a deep bed of alluvium; *Sir T. L. Mitchell*, 1842.
2. Hodgson, Campbell, Isaac, and Oaky creeks, Condamine River, either in red loamy breccia, or a bed of pebbles; *L. Leichhardt*, 1844.
3. King's Creek, Darling Downs; — *Turner*, 1847.
4. Isaac's Creek, Gowrie, Darling Downs; *F. N. Isaacs*, 1849.
5. Galtindaddai, Melville Plains; *W. Buchanan*, 1851.
6. Creeks, Darling Downs; *H. Hughes*, 1856.
7. Gowrie, Darling Downs; *J. E. Allport*, 1869.
8. Condamine Valley, 100 feet below surface; *J. H. Hood*, 1861.
9. Eton Vale, Darling Downs; *E. S. Hill*, 1863.
10. St. Ruth's Station, Condamine River; *H. Campbell*, 1865.
11. St. Jean Station, Condamine River; *S. St. Jean*, 1865.
12. Clifton Plains, Darling Downs; *F. Nicholson*, 1866.
13. King's Creek, Clifton Station, Darling Downs; *G. F. Bennett*, 1877 (about).

This list of localities does not appear to include that of the original skull sent to London by Mr. Boyd and purchased for the British Museum. It was from the "bed of a creek at Gowrie, near Drayton, Darling Downs," and is probably identical, says Sir R. Owen, with the head referred to by Dr. G. Bennett as found by a shepherd on King's Creek.

To the above must be added the discovery of *Diprotodon* remains in brecciated alluvium by the late Mr. R. Daintree, on Maryvale Creek, Clarke River.‡

*Loc. and Horizon.* As given above—Fluviatile deposits.

\* *Proc. R. Soc.*, 1870, xvii., p. 196.

† *Phil. Trans.*, 1870, clx., p. 570; *Extinct Mam. Australia*, 1877, pp. 240 and 507. The numerous localities at which *Diprotodon* remains have been found by the Geological Survey of New South Wales and Collectors in South Australia and Queensland are not included here.

‡ *Quart. Journ. Geol. Soc.*, 1872, xxviii., Pt. 3, p. 274.



## DIPROTODON MINOR, Huxley.

*Diprotodon minor*, Huxley, Quart. Journ. Geol. Soc., 1862, xviii., p. 422, t. 21, ff. 4-6.\*

*Nototherium*, sp., Owen, Extinct Mam. Australia, 1877, p. 511.

*Diprotodon minor*, Etheridge fil., Cat. Australian Foss., 1878, p. 181.

" " De Vis, Proc. R. Soc. Queensland, 1888, v., Pt. 2, p. 38, Pl., top figs.

*Obs.* The fossils described by Prof. Huxley as representing a small species of *Diprotodon* appear to be regarded by Sir R. Owen as a *Nototherium*, if we may judge by the very brief remarks he makes in his "Extinct Mammals of Australia." Latterly Mr. De Vis has studied *Diprotodon minor*, and states that both of the species figured by Huxley "were in 1887 identified by Sir R. Owen with ascertained species of his genus *Nototherium*; *D. (australis?)* was figured as *N. Mitchelli*, *D. minor* as *N. victoriae*."

I have failed to find any identification of this kind by Prof. Owen, who simply suggests to the reader a comparison of Huxley's *D. minor* with his *Nototherium Mitchelli*. The conclusions arrived at by Mr. De Vis are as follows:—"The premolars figured by Professor Huxley are unmistakably those of *Diprotodon*. The distinctness of the animal they represent from *D. australis*, affirmed with some reserve by Prof. Huxley, and practically without reserve by Sir R. Owen, is confirmed by fresh evidence. The differences between the three premolars made known are reconcilable, the difficulty raised by them less than that of admitting three allied species in the same habitat. They represent one form, *D. minor*, which is a species, and not the female of *D. australis*. The genus therefore combines two species, *D. australis*, Ow., and *D. minor*, Hux."

*Loc. and Horizon.* Gowrie, Darling Downs (*F. N. Isaac*)—Fluviatile deposits.

## Genus—EUOWENIA, De Vis, 1891.

*Owenia*, De Vis, Proc. R. Soc. Queensland, 1887, iv., p. 100 (non Presch, nec Kölliker).

*Euowenia*, De Vis, Proc. Linn. Soc. N. S. Wales, 1891, vi. (2), Pt. 2, p. 160.

## EUOWENIA GRATA, De Vis.

*Owenia grata*, De Vis, Proc. R. Soc. Queensland, 1887, p. 100, t. 1-4; *Ibid.*, 1888, v., Pt. 3, 2nd plate (lower figs).

*Euowenia grata*, De Vis, Proc. Linn. Soc. N. S. Wales, 1891, vi. (2), Pt. 2, p. 160 and 165.

*Obs.* A new genus of Diprotodontidæ, with the dental formula *i.*  $\frac{3}{1}$ , *p.m.*  $\frac{1}{1}$ , *m.*  $\frac{4}{1}$ . A full description will be found in the Author's Paper "On an Extinct Mammal of a Genus apparently new." From this the following general remarks are extracted:—"The affinity of *Owenia* to the gravigrade Diprotodons known by their cranial remains is plainly expressed by the structure of its grinding teeth. Had these alone been left to us, it would have been difficult to avoid the error of referring them to a small species of *Nototherium*. The incisors, on the other hand, are so strongly differentiated, not only from those of *Diprotodon*, *Nototherium*, and *Sthenomelus*, but from those of the phytophagous marsupials generally, that, had these been our sole guides, we might have been led to speculate on the existence of a carnivore more destructive than *Thylacoleo*; but its general relationship being evident, it is only necessary to ascertain to which of the older and better known genera it has the nearest alliance. The absence of the dilated muzzle, flat face, elevated forehead, huge zygomata, and strongly inflected mandibular angle of *Nototherium*, shows that in its leading characters its affinity to that genus was anything but close. From *Diprotodon* it was not so far removed; in the several features in which it departs from *Nototherium*, it approaches—or rather departs

\* In his Paper on *Diprotodon minor* Mr. De Vis commits a strange bibliographical error. He quotes as the original reference to this species the "Annals and Magazine of Natural History," vol. xviii., pp. 422-427. It should be as above given.

from—its more ponderous contemporary. In the conformation of the posterior moiety of the mandible, that of the condyle excepted, it indeed resembles *Diprotodon* rather closely; the position of the dental foramen in the two is almost identical, and the chief difference is the relatively greater development of the alar expansion in the newer genus."

The premolars are described in general terms as simple unilobate teeth; the upper one subtriangular in section, with the subcentral conical cusps longitudinally constricted towards the apex, the constriction being still seen in a contraction of the dentinal band, as it traverses obliquely the longitudinal axis of the tooth. The lower premolar is structurally the same as in *Nototherium*, as identified by Owen, therefore the upper one of *Nototherium* should not differ widely from that of the present genus.

In his last communication, Mr. De Vis has wisely changed the name from *Owenia* to *Euowenia*, the former having been preoccupied no less than three times—in 1847 by Presch for a genus of Cephalopoda; in 1853 by Köllicker for a Cœlenterate, and, according to Count Marschall, by one of the Agassiz in 1860 for a Ctenophore.

*Loc. and Horizon.* Chinchilla, Darling Downs (*K. Broadbent*—Colln. Queensland Mus.)—Chinchilla Conglomerate.

#### EUOWENIA ROBUSTA, *De Vis*.

*Euowenia robusta*, De Vis, Proc. Linn. Soc. N. S. Wales, 1891, vi. (2), Pt. 2, p. 160.

*Obs.* A second species founded on "the inferior moiety of the articulating limb with the dentary limb of the left side in natural conjunction with the anterior half of the dentary limb of the right side, all the teeth of the parts preserved being in place except *m.*<sup>3</sup> of the left side."

This fossil represents a very much more robust animal than *E. grata*, with a lower symphysial gradient, a parabolic instead of an angular inferior contour, and compressed rather than rotund incisors.

*Loc. and Horizon.* Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Fluviatile deposits.

#### Family—PHALANGERIDÆ.

*Genus*—*PHALANGER*, *Storr*, 1780.

(Prod. Meth. Mam., p. 33.)

#### PHALANGER PROCUSCUS, *De Vis*.

*Cuscus procuscus*, De Vis, Proc. R. Soc. Queensland, 1889, vi., Pts. 2 and 3, p. 111, t. 5, lower right-hand fig.

*Obs.* The anthral end of a right scapula has been referred to the genus *Phalanger* (*Cuscus*) under the above name, the Author remarking that it "brings us into nearer contemplation of the recent genus *Cuscus* than was permitted to us by *Archizonurus*." Its size was about equal to that of the last-named genus, and its nearest living ally is *Phalanger* (*Cuscus*) *orientalis*, a New Hebridean species. Touching the size of this extinct "Possum," the Author remarks—"The greatest breadth of the glenoid fossa in the fossil is sixfold that of *P. Archeri*; its length has nearly the same proportion. *P. Archeri* is 310 mm. in length, sine cauda, and weighs about four pounds. *Archizonurus* may, therefore, be estimated to have been about six feet in length, and 850 lb. in weight."

*Loc and Horizon.* Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Fluviatile deposits.

*Genus—PSEUDOCHIRUS, Ogilby, 1836.*

(Proc. Zool. Soc., 1836, p. 26.)

*PSEUDOCHIRUS ? NOTABILIS, De Vis.**Pseudochirus notabilis*, De Vis, Proc. R. Soc. Queensland, 1889, vi., Pts. 2 and 3, p. 113, t. 5, lower left-hand fig.

*Obs.* A maxillary with the premolar (*pm.* 4) and three succeeding molars is referred by Mr. De Vis provisionally to *Pseudochirus* "as the most likely amongst living genera to have been transmitted through it, but at the same time a possible affinity with *Cuscus* on the one hand and even *Phascolarctos* on the other is not to be altogether ignored." *P. notabilis* is believed to have been as large as a Koala, and would consequently weigh about twenty pounds.

*Loc. and Horizon.* Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Fluviatile deposits.

*Genus—KOALEMUS, De Vis, 1889.*

(Proc. R. Soc. Queensland, vi., Pts. 2 and 3, p. 106.)

*KOALEMUS INGENS, De Vis.**Koalemus ingens*, De Vis, Proc. R. Soc. Queensland, 1889, vi., Pts. 2 and 3, p. 106, t. 5, up. right-hand fig.

*Obs.* This genus and species are founded on the distal end of a right fibula—and there is also provisionally referred to it a premaxillary with its palatal process—of an animal allied to, although not congeneric with *Phascolarctos*, the Native-bear.

The fossil bone is said to have a strong general resemblance in form and arrangement of its parts with the corresponding one in the living animal, but the following differences given in the Author's words may be taken as distinctive:—"The anterior segment of the epectosphere produced but very slightly at its anterior angle, forming a roughened triangular plane, impinging by the posterior angle upon the side of the posterior segment. The groove segmenting the epectosphere is broadly concave at the base. The shaft subquadrate, flattened on the exterior and anterior sides, which meet on a strong angular ridge continued distal to the anterior segment. Expansion of the shaft, proximal of the epiphysis, very moderate."

Mr. De Vis adds that taking the weight of an adult Koala or Native-bear at twenty pounds, that of the extinct form would in comparison "be estimated at five hundred-weight or more."

*Loc. and Horizon.* Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Fluviatile deposits.

*Genus—ARCHIZONURUS, De Vis, 1889.*

(Proc. R. Soc. Queensland, vi., Pts. 2 and 3, p. 109.)

*ARCHIZONURUS SECURUS, De Vis.**Archizonurus securus*, De Vis, Proc. R. Soc. Queensland, 1889, vi., Pts. 2 and 3, p. 109, t. 5, up. left-hand fig.

*Obs.* An extinct true Phalanger founded on the distal third of a shoulder blade "distinguished by a large dilated and incrassated coracoid, which firmly denies all relationship with families other than the Phalangistidæ." In form this bone is hardly to be distinguished from the corresponding one in the Toolah, *Phalangista Archeri*, but it differs from this and all other Phalangiers "in not having its rostral edges brought together and produced at the point into a bicapital tubercle; the external edge is, on the contrary, reflected upon the ectal surface of the bone."

*Loc. and Horizon.* Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Fluviatile deposits.

Genus—*THYLACOLEO*, Owen, 1858.

(Proc. R. Soc., ix., p. 565.)

*THYLACOLEO CARNIFEX*, Owen.

- Thylacoleo carnifex*, Owen, Phil. Trans., 1859, cxlix., p. 309, t. 11, f. 1-6, t. 13, f. 1, 4-8, t. 14, f. 1, t. 15, f. 1; *Ibid.*, 1866, clvi., Pt. 1, p. 73, t. 2, 3, and 4; *Ibid.*, 1871, clxi., Pt. 1, p. 213, t. 11, 12, 13, and 14; *Ibid.*, 1883, clxxiv., Pt. 2, p. 575, t. 39, 40, and 41, f. 1 and 2, p. 639, t. 46, f. 1.
- „ „ Owen, Extinct Mam. Australia, 1877, p. 107, t. 6, f. 1, 6, 9, 10, and 12, t. 7, f. 1-14, t. 8, f. 1-6, 11 and 13, t. 9, f. 1-9, t. 10, t. 11, t. 13, f. 1, 4-8, t. 14, f. 1, t. 15, f. 1, t. 16, 17, and 18.
- „ „ Owen, Geol. Mag., 1883, x., p. 289, t. 7.

*Obs.* The sectorial teeth of this species demonstrate the presence, during Post-Tertiary times, of a large Carnivore, the marsupial character of which is indicated by the name “Marsupial or Pouched Lion.” The dental formula is  $i. \frac{2-3}{1-2}, c. \frac{1-1}{0-0}, p. \frac{4-5}{4-4}, m. \frac{1-1}{3-3} = 30$ .

Mr. C. W. De Vis has lately described \* a femur, believed by him to be that of *Thylacoleo*, from the Darling Downs. He remarks—“The bone is in general form unlike any recent femur known to the Writer, inasmuch as it tapers gradually from the proximal end to the distal third-fifth, and is in its proximal moiety rather strongly curved, both inwards and outwards.” Again—“The fossil resembles the femur of the Carnivore in the shortness and direction of the lesser trochanterian ridge, in the obliquity of the post trochanterian fossa, in the shape of the head, in that of the shaft anteriorly, and generally of the whole distal extremity. To this we may add that the backward curvature of the shaft is found in the allied genus *Dasyurus*. On the other hand, it resembles the corresponding bone in *Phascolomys* in the shape of the great trochanter exteriorly, in the prominence of the lesser trochanter, in the insertion of the ligamentum teres, in the depth of the neck between the great trochanter and the head, and in the turgidity of the space between the fossa and the head. In brief, its proximal extremity, with prevailing characters of its own, has more of *Phascolomys* than of *Sarcophilus* in its composition, while its shaft and distal end show relation almost exclusively (as between these two) to *Sarcophilus*. But withal there are features of *Macropus* not to be overlooked: the angle of articulation, the shape anteriorly and length of the outer condyle, the tumid quadratus insertion, and the extra-condylar groove. We may sum up the whole by saying that sarcophiline affinities are dominant, phascolomine subordinate, macropine concomitant.”

*Loc. and Horizon.* Gowrie, Darling Downs (*S. St. Jean*); Hodgson's Creek, Darling Downs (*The late S. Strutchbury*); Eton Vale, Darling Downs (*E. S. Hill*); King's Creek, Darling Downs (*The late C. H. Hartmann*)—Fluviatile deposits.

## Family—MACROPODIDÆ.

Genus—*MACROPUS*, Shaw, 1800.

(Gen. Zoology, i., Pt. 2, p. 505.)

*Obs.* Throughout this family I have, as far as possible, adopted the subdivisions proposed by Prof. Owen, and his references; but, for the sake of convenience, the subgenera are treated as genera. This does not altogether accord with Mr. Lydekker's arrangement in the British Museum “Catalogue of Fossil Mammalia,” Part 5, where *Leptosiaigon*, *Pachysiaigon*, *Osphranter*, *Phascolagus*, and in part *Protemnodon* and

\* On a Femur, probably of *Thylacoleo*. Proc. R. Soc. Queensland, 1886, iii., p. 122, t. 3.

*Sthenurus*, are merged in *Macropus*. The greater portion of this section of the present work was compiled before the appearance of the British Museum Catalogue, and to this the reader is referred for the unravelling of the intricate synonymy attached to these fossils. The fossil Macropodidæ have recently been re-studied by Mr. De Vis in the light thrown on them by the very large Collection in the Queensland Museum, but the results await publication.

#### MACROPUS TITAN, Owen.

- Macropus titan*, Owen, in Mitchell, Three Exped. Int. E. Australia, 1838, ii., p. 359, t. 29, f. 3, 6, and 8.  
 " " Owen, Descrip. Cat. Mam. Aves R. Col. Surgeons, 1845, p. 324, Nos. 1510-12, 1526, 1528-1531, t. 6, f. 7.  
 " " Phil. Trans., 1874, clxiv., Pt. 1, p. 248, t. 20, f. 29, t. 21, f. 6-18, t. 22, f. 10-18, t. 23, f. 2 and 3, 12 and 13, t. 26, f. 9-15; *Ibid.*, 1874, Pt. 2, p. 783, t. 76, f. 1-6; *Ibid.*, 1876, clxvi., Pt. 1, p. 204, t. 25, f. 1 and 4, t. 26, f. 1 and 2, t. 27.  
 " " Owen, Extinct Mam. Australia, 1877, pp. 400, 435, 489, 499, t. 76, f. 1 and 4, t. 77, f. 1 and 2, t. 79, f. 1 and 2, t. 80, f. 29, t. 81, f. 6-18, t. 82, f. 10-18, t. 83, f. 2 and 3, 12 and 13, t. 86, f. 9-15, t. 69, f. 1-6, t. 112 and 113, t. 118, f. 1-7.  
 " " Etheridge fil., Cat. Australian Foss., 1878, p. 183 (*for full synonymy*).  
 " " Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 225.

*Obs.* The former existence of this species was determined by Prof. Owen upon the evidence afforded by portions of several jaws and a humerus, &c., obtained from the Wellington Valley Caves and the Queensland Freshwater deposits. The remains exceeded in size those of the living *Macropus major*. The humerus exceeds in length that of the last-named species as much as that of *Phascolagus* falls short of it, and the strength or thickness of this bone is greater than in the latter.

In addition to these remains, a very fine skull, more or less complete, was obtained by Mr. W. F. Tooth, Junr., at King's Creek, Darling Downs, the measurements of which, as compared with a skull of *Macropus major*, are given by Sir R. Owen.\*

*Macropus titan* is closely allied to the living *M. giganteus*, "but is distinguished by its superior size, and the very general occurrence of one or more vertical grooves on the hinder surfaces of the lower true molars; it is, however, probable that the two forms pass imperceptibly into one another."

*Loc. and Horizon.* Condamine River, west of Moreton Bay (*Sir T. L. Mitchell*—Colln. College of Surgeons, London); Darling Downs (*H. Hughes*—Colln. Worcester Nat. Hist. Soc.); Darling Downs (*Sir C. Nicholson*—Colln. Oxford Museum); Gowrie, Darling Downs (*Dr. G. Bennett*); King's Creek, Darling Downs (*W. F. Tooth, Junr., and Dr. G. Bennett*)—Fluviatile deposits; Maryvale Creek, Clarke River (*The late R. Daintree*)—Diprotodon-breccia.

#### MACROPUS AFFINIS, Owen.

- Macropus affinis*, Owen, Descrip. Cat. Mam. Aves R. Coll. Surgeons, 1845, p. 328, No. 1524.  
 " " Owen, Phil. Trans., 1874, clxiv., Pt. 1, p. 260, t. 23, f. 10 and 11; *Ibid.*, 1876, clxvi., Pt. 1, p. 217, t. 29, f. 6, t. 30, f. 7-9.  
 " " Owen, Extinct Mam. Australia, 1877, pp. 411 and 498, t. 83, f. 10 and 11, t. 116, f. 6, t. 117, f. 7-9.  
 " " Etheridge fil., Cat. Australian Foss., 1878, p. 183 (*for full synonymy*).

*Obs.* Under this name Sir R. Owen described a left mandibular ramus with teeth, indicating a species of less size than *Macropus titan*. He remarks—"Evidence of an extinct Kangaroo of intermediate proportions between the largest known living species and those defined in my original Memoirs."†

*Loc. and Horizon.* Condamine River, west of Moreton Bay (*Sir T. L. Mitchell*—Colln. College of Surgeons, London); King's Creek, Darling Downs (*G. F. Bennett*)—Fluviatile deposits.

\* Extinct Mam. Australia, 1877, p. 436.

† Phil. Trans., 1874, clxiv., Pt. 1, p. 260.

**MACROPUS AJAX, Owen.**

*Macropus ajax*, Owen, Quart. Journ. Geol. Soc., 1850, xv., p. 155, note.

**Obs.** This name was applied to a lower jaw which does not appear to have been referred to in any of Prof. Owen's subsequent Memoirs.

**Loc. and Horizon.** Darling Downs (*H. Hughes*—Colln. Worcester Nat. Hist. Soc.)—Fluviatile deposits.

**MACROPUS ROBUSTUS, Gould.**

*Petrogale robusta*, Gould, Mon. Macropodidae, 1841, t. 5.

*Osphranter robustus*, Gray, List Spec. Mam. Brit. Mus., 1843, p. 91.

*Macropus robustus*, Lydekker, Cat. Foss. Mam. Brit. Mus., Pt. 5, 1887, p. 222.

**Loc. and Horizon.** Gowrie, Darling Downs (*G. F. Bennett*—Colln. Brit. Mus.)—Fluviatile deposits.

**MACROPUS, sp. ind. (a).**

*Macropus*, sp., Owen, Descrip. Cat. Mam. Aves. R. Coll. Surgeons, 1845, p. 326, No. 1517.

**Obs.** A ramus of a lower jaw was retained by Prof. Owen in the Royal College of Surgeons Catalogue as a distinct species. It presented evidence of more molars in use at one time than in the recent *Macropus laniger* or *M. major*.

**Loc. and Horizon.** Condamine River, west of Moreton Bay (*Sir T. L. Mitchell*—Colln. College Surgeons, London)—Fluviatile deposits.

**MACROPUS, sp. ind. (b).**

*Macropus*, sp., Owen, Extinct Mam. Australia, 1877, p. 491, t. 114.

**Obs.** An almost entire femur has been described by Sir R. Owen, and does not appear referable to any described species.

**Loc. and Horizon.** King's Creek, Darling Downs—Fluviatile deposits.

**Genus—LEPTOSIAGON, Owen, 1873.**

(Proc. Roy. Soc., xxi., p. 386.)

**LEPTOSIAGON GRACILIS, Owen.**

*Leptosiagon gracilis*, Owen, Proc. R. Soc., 1873, xxi., p. 386.

" " Owen, Phil. Trans., 1874, clxiv., Pt. 2, p. 785, t. 76, f. 11-15.

" " Owen, Extinct Mam. Australia, 1877, p. 450, t. 89, f. 11-15.

**Obs.** Prof. Owen considers *Leptosiagon* to be a sub-genus of *Macropus*. He adds—"The distinctive dental character of the present sub-genus is in the sculpturing of the hind surface of the molars," and the mandible appears to have been unusually thin in proportion to its depth. Mr. Lydekker remarks that the specimen on which this species was founded presents no distinguishable difference from *Macropus (Pachysiagon) ferragus*, Owen.\*

**Loc. and Horizon.** The only locality afforded is that of "Queensland." Probably from Darling Downs.—Fluviatile deposits.

**Genus—OSPHRANTER, Gould, 1841.**

(Proc. Zool. Soc., Pt. ix., p. 80.)

**OSPHRANTER COOPERI, Owen.**

*Osphranter Cooperi*, Owen, Proc. R. Soc., 1873, xxi., p. 128.

" " " Phil. Trans., 1874, clxiv., Pt. 1, p. 261, t. 24, f. 17 and 18.

" " " Extinct Mam. Australia, 1877, p. 412, t. 84, f. 17 and 18.

*Macropus Cooperi*, Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 234.

**Obs.** This name was applied by Prof. Owen to the "fore part of the left mandibular ramus of an aged individual of a Wallaroo, of the size of *Osphranter robustus*."

**Loc. and Horizon.** Darling Downs, Queensland—Fluviatile deposits.

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\* Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 231.

OSPHRANTER GOULDII, *Owen*.

*Osphranter Gouldii*, Owen, Proc. R. Soc., 1873, xxi., p. 128.

" " Phil. Trans., 1874, clxiv., Pt. 1, p. 261, t. xxiii., f. 15 and 16.

" " Extinct Mam. Australia, 1877, p. 413, t. 83, f. 15 and 16.

*Obs.* A corresponding but smaller species of Wallaroo than the last. The name was also founded on the left mandibular ramus. Mr. Lydekker refers this to the living *Macropus Parryi*, Bennett.\*

*Loc. and Horizon.* Darling Downs.—Fluviatile deposits.

Genus—*PALORCHESTES*, *Owen*, 1873.

(Proc. R. Soc., xxi., p. 386; Phil. Trans., 1874, clxiv., Pt. 2, p. 797.)

*PALORCHESTES AZAEL*, *Owen*.

*Palorchestes azael*, Owen, Phil. Trans., 1874, clxiv., Pt. 2, p. 798, t. 81, f. 1 and 2, t. 82, f. 1 and 2, t. 83, f. 1; *Ibid.*, 1876, clxvi., Pt. 1, p. 197, t. 19-21, t. 22, f. 1-4, t. 23, f. 1, 2, and 5, t. 24, t. 29, f. 1-3.

" " Owen, Extinct Mam. Australia, 1877, pp. 466 and 500, t. 96, f. 1 and 2, t. 97, f. 1 and 2, t. 106, f. 1, t. 106 and 107, t. 115, f. 1, 2, and 5, t. 116, f. 1-3, t. 129, t. 130, f. 1-4, t. 131.

" " De Vis, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 2, p. 221.

" " Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 237.

*Obs.* Portions of jaws were described by Sir R. Owen, under this name, without assigning to them any definite locality. He considers that these remains deviate less from the type of the bilophodont Macropodidæ than those of *Procoptodon*, some of which, *P. Goliath*, for example, were of larger bulk. The entire skull would probably measure about sixteen inches in length.

Mr. De Vis has described a portion of the jaw and dentition, since the appearance of Owen's "Extinct Mammals of Australia." He considers *P. azael* to have been a true saltigrade of Macropodoid type.

*Loc. and Horizon.* Near St. Ruth, Darling Downs, at a depth of seventy feet from the surface (*C. W. De Vis*—Colln. Queensland Mus.)—Fluviatile deposits.

Genus—*PACHYSIAGON*, *Owen*, 1873.

(Proc. R. Soc., xxi., p. 386.)

*Obs.* This name was applied by Sir R. Owen to two extinct species of Macropodidæ in which the massiveness of the mandible was greatly in excess of the teeth it supported.

*PACHYSIAGON FERRAGUS*, *Owen*.

*Macropus Ferragus*, Owen, Phil. Trans., 1874, clxiv., Pt. 2, p. 784, t. 81, f. 4, t. 82, f. 3 and 4, t. 105, f. 3.

*Pachysiagon Ferragus*, Owen, Extinct Mam. Australia, 1877, p. 449, t. 96, f. 4, t. 97, f. 3 and 4, t. 105, f. 3.

*Obs.* A portion of right mandibular ramus indicated to Prof. Owen, by the size of the teeth and the jaw itself, a Kangaroo exceeding in size the *Macropus titan*. Mr. Lydekker refers this species to *Macropus*, and unites with it *Leptosiagon gracilis*, Owen.

*Loc. and Horizon.* Condamine River, Darling Downs (Colln. Brit. Mus.)—Fluviatile deposits.

*PACHYSIAGON OTUEL*, *Owen*.

*Pachysiagon otuel*, Owen, Phil. Trans., 1874, clxiv., Pt. 2, p. 784, t. 76, f. 7-10.

*Procoptodon otuel*, Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 236.

*Obs.* This species is said to show the typical generic characters in a more marked manner than *P. ferragus*.

\* Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 220.

*Loc. and Horizon.* King's Creek, Darling Downs (*G. B. King*—Colln. Brit. Mus.)—Fluviatile deposits.

*Genus*—*PHASCOLAGUS*, *Owen*, 1873.

(Proc. R. Soc., xxi., p. 128; Phil. Trans., 1874, clxiv., Pt. 1, p. 261.)

*PHASCOLAGUS ALTUS*, *Owen*.

*Macropus titan*, *Owen*, in Mitchell Three Expeds. Int. E. Australia, 1838, ii., t. 29, f. 4 and 5 (excl. f. 3, 6, and 8).

*Phascolagus altus*, *Owen*, Phil. Trans., 1874, clxiv., Pt. 1, p. 261, t. 22, f. 1 and 2; *Ibid.*, 1876, clxvi., Pt. 1, p. 218, t. 30, f. 1-6.

„ „ *Owen*, Extinct Mam. Australia, 1877, pp. 414 and 498, t. 82, f. 1 and 2, t. 117, f. 1-6.

*Macropus altus*, *Lydekker*, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 223.

*Obs.* Of this species Sir R. Owen has described a right maxillary with teeth, and a metatarsal. Teeth of the molar series are equal in extent and size to those of *Macropus rufus* and *M. major*. The pattern of the grinding surfaces of the upper molars is more like that in *Halmaturus* and *Osphranter* than in either *Macropus major* or *M. titan*.

*Loc. and Horizon.* King's Creek, Darling Downs (*Dr. G. Bennett*)—Fluviatile deposits.

*Genus*—*PROCOPTODON*, *Owen*, 1873.

(Proc. R. Soc., xxi., p. 386; Phil. Trans., 1874, clxiv., Pt. 2, p. 786.)

*PROCOPTODON FUSIO*, *Owen*.

*Procoptodon pusio*, *Owen*, Phil. Trans., 1874, clxiv., Pt. 2, p. 788, t. 77, f. 2-7; *Ibid.*, 1876, clxvi., Pt. 1, p. 222, t. 31, f. 1-5, 10-12.

„ „ *Owen*, Extinct Mam. Australia, 1877, p. 454, t. 89, f. 7-10, t. 90, f. 2-7, t. 91, t. 119, f. 1-5, 10-12.

*Obs.* The remains of this species, examined by Prof. Owen, consisting of jaws with teeth, a metatarsal, &c., indicated a Kangaroo one-third larger than *Osphranter robustus*, Gould.

A large unossified tract of the palate, which is shown in both maxillaries of this genus, is not present in the large existing Kangaroos of the genera *Macropus* and *Osphranter*. It is present, adds Prof. Owen, under some modifications, in *Boriogale*, *Halmaturus*, and *Petrogale*, and such similar small Kangaroos and Wallabies.

*Loc.* The former is not stated, but probably Darling Downs—Fluviatile deposits.

*PROCOPTODON GOLIAH*, *Owen*.

*Macropus goliah*, *Owen*, in Waterhouse, Nat. Hist. Mam., 1846, i., p. 59.

*Procoptodon goliah*, *Owen*, Phil. Trans., 1874, clxiv., Pt. 2, p. 791, t. 79, t. 80; *Ibid.*, 1876, clxvi., Pt. 1, p. 222, t. 22, f. 5, t. 23, f. 3 and 4.

„ „ *Owen*, Extinct Mam. Australia, 1877, p. 454, f. 89, f. 7-10, t. 90, f. 2-7, t. 91, t. 119, f. 1-5, 10-12.

„ „ *Lydekker*, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 235.

*Obs.* The portions of this Kangaroo hitherto obtained consist of parts of jaws, of a hind foot, and a left femur.

*Loc. and Horizon.* Darling Downs, at a depth of forty feet from the surface—(Colln. College of Surgeons, London; Colln. Brit. Mus.; Colln. Australian Mus.)—Fluviatile deposits.



## PROCOPTODON RAPHA, Owen.

*Procoptodon Rapha*, Owen, Phil. Trans., 1874, clxiv., Pt. 2, p. 788, t. 77, f. 8-12, t. 78; *Ibid.*, 1876, clxvi., p. 222, t. 81, f. 6-9.

" " Owen, Extinct Mam. Australia, 1877, pp. 457, 483, 494, 502, t. 90, f. 8-12, t. 93, t. 119, f. 6-9, t. 128.

*Obs.* *P. rapha*, from the portions hitherto found, consisting of a lower jaw, femur, metatarsals, &c., would appear to be of larger size than *P. pusio*, but inferior to *P. goliath*. The characters of the jaw are nearer to those of *Nototherium* than is usually shown in Macropodoid genera.

*Loc. and Horizon.* Gowrie, Darling Downs (*G. F. Bennett*)—Fluviatile deposits.

## Genus—PROTEMNODON, Owen, 1873.

Proc. R. Soc., 1873, xxi., p. 128; Phil. Trans., 1874, clxiv., Pt. 1, p. 274.)

*Obs.* *Protemnodon* is allied to *Sthenurus*, but is distinguished by the "more simple trenchant shape of the crown of the premolars." The upper molars are more like those of *Sthenurus atlas* than those of *Macropus titan*.

## PROTEMNODON ANAK, Owen.

*Macropus atlas*, Owen, Descrip. Cat. Mam. Aves. R. Coll. Surgeons, 1845, pp. 325 and 327, Nos. 1513 and 1519.

*Protemnodon anak*, Owen, Phil. Trans., 1874, clxiv., Pt. 1, p. 275, t. 23, f. 4-9, f. 1-4, 7-10, and 14.

" " Owen, Extinct Mam. Australia, 1877, pp. 428, 449, 498, t. 83, f. 4-9, t. 85, f. 1-4, 7-10, and 14, t. 120, f. 1-6.

*Obs.* The remains of this old Kangaroo hitherto found consist of a lower jaw, metatarsal, and other smaller bones.

*Loc. and Horizon.* Condamine River, West of Moreton Bay (*Sir T. L. Mitchell*—Colln. Coll. Surgeons, London); Darling Downs (—*Hughes*—Colln. Worcester Nat. Hist. Soc.); Eton Vale, Darling Downs (*E. S. Hill*—Colln. Brit. Mus.)—Fluviatile deposits.

## PROTEMNODON ANTEUS, Owen.

*Protemnodon Antæus*, Owen, Extinct Mam. Australia, 1877, p. 448, t. 88, f. 18, t. 110.

*Obs.* The remains of this species, consisting of a right and left mandibular ramus, with molar dentition, are described by Sir R. Owen without affixing a locality.

This is united by Mr. Lydekker with *Protemnodon ræchus*, Owen, and referred to *Macropus*.

*Loc. and Horizon.* Clifton, Darling Downs (*Dr. G. Bennett and F. N. Isaacs*—Colln. Brit. Mus.); Gowrie, Darling Downs (*Dr. G. Bennett*—Colln. Brit. Mus.)—Fluviatile deposits.

## PROTEMNODON MIMAS, Owen.

*Protemnodon mimas*, Owen, Phil. Trans., 1874, clxiv., Pt. 1, p. 278, t. 24, f. 13-16, t. 26, f. 1-8, t. 27, f. 1-4 and 14.

" " Owen, Extinct Mam. Australia, 1877, pp. 431, 447, t. 84, f. 13-16, t. 86, f. 1-8, t. 87, f. 1-4 and 14.

*Obs.* In this species, says Professor Owen, "a greater depth and thickness of mandible, and a concomitant large size of molars, are associated with a relatively smaller size of the trenchant premolar, which does not exceed that in *P. anak*."

This is united by Mr. Lydekker with *Sthenurus brehus*, Owen, and referred to *Macropus*.

*Loc. and Horizon.* Gowrie Creek, Darling Downs (*Dr. G. Bennett*); Eton Vale, Darling Downs (*Sir D. Cooper*—Colln. Brit. Mus.)—Fluviatile deposits.

PROTEMNODON OG, Owen.

*Protemnodon Og*, Owen, Phil. Trans., 1874, clxiv., Pt. 1, p. 277, t. 25, f. 5 and 6, 11-13.

" " Owen, Extinct Mam. Australia, 1877, p. 430, t. 85, f. 5 and 6, 11-13.

*Obs.* Of this species Prof. Owen remarks—"With a certain increase of size of both mandible and molar teeth, represents the form and size of the premolars in *P. Anak*."

Mr. Lydekker unites the specimens with *Protemnodon anak*, Owen, in part, and *Sthenurus atlas*, Owen, in part, and refers them to *Macropus*.

*Loc. and Horizon.* Gowrie, Darling Downs (*Sir D. Cooper*—Colln. Brit. Mus.)—Fluviatile deposits.

PROTEMNODON RACHUS, Owen.

*Protemnodon rachus*, Owen, Phil. Trans., 1874, clxiv., Pt. 1, p. 281, t. 27, f. 10-13.

" " Owen, Extinct Mam. Australia, 1877, p. 434, t. 87, f. 10-13.

*Obs.* In a left mandibular ramus "the molars have the characters of those of *P. anak* . . . but the increase in size is more than can be granted to difference of sex."

*Loc. and Horizon.* King's Creek, Clifton Station, Darling Downs (*G. King*)—Fluviatile deposits.

Genus—*STHENURUS*, Owen, 1873.

(Proc. R. Soc., xxi., p. 128.)

*STHENURUS ATLAS*, Owen.

*Macropus Atlas*, Owen, in Mitchell Three Expeds. Int. E. Australia, 1838, ii., p. 350, t. 29, f. 1.

" " Owen, Descrip. Cat. Mam. Aves R. Coll. Surgeons, 1845, pp. 325-330, Nos. 1513-16, 1519-1520, 1525, and ? 1527.

*Sthenurus atlas*, Owen, Phil. Trans., 1874, clxiv., p. 265, t. 20, f. 30, t. 22, f. 3-9, t. 24, f. 4-9; *Ibid.*, 1876, clxvi., Pt. 1, p. 210.

" " Owen, Extinct Mam. Australia, 1877, pp. 416, 430, 446, t. 76, f. 2 and 3, t. 77, f. 4 and 5, t. 79, f. 4, t. 80, f. 30, t. 82, f. 3-9, t. 84, f. 4-9, t. 88, f. 1-4.

" " Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 232.

*Obs.* The form and structure of the premolars in this and its fellow species, as compared with their proportion to the molars behind, indicate, according to Prof. Owen, a distinct sub-genus of Macropodidæ. The name *Sthenurus* was suggested by the form and proportions of the vertebræ of the very powerful tail of this great extinct Kangaroo. The portions hitherto recorded consist of jaws with teeth, portion of a skull, and tail vertebræ.

*Loc. and Horizon.* Darling Downs (*Sir C. Nicholson*—Colln. Oxford University Mus.); Gowrie, Darling Downs (*Sir D. Cooper*—Colln. Brit. Mus.)—Fluviatile deposits.

*STHENURUS BREHUS*, Owen.

*Sthenurus Brehus*, Owen, Phil. Trans., 1874, clxiv., Pt. 1, p. 272, t. 27, f. 5-9; *Ibid.*, 1876, clxvi., Pt. 1, p. 212, t. 28.

" " Owen, Extinct Mam. Australia, 1877, pp. 424, 442, 449, t. 87, f. 5-9, t. 88, f. 5-10, t. 92, f. 6 and 7, t. 108, t. 109, ? t. 77, f. 7.

*Macropus brehus*, Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 207.

*Obs.* The foremost of the upper incisors in this species "has a greater relative superiority of size over the second and third than in any existing species of Kangaroo."

*Loc. and Horizon.* Clifton Station, Darling Downs.—Fluviatile deposits.

*Genus—STHENOMERUS, De Vis, 1883.*

(Proc. Linn. Soc. N. S. Wales, viii., Pt. 1, p. 15.)

*STHENOMERUS CHARON, De Vis.**Sthenomerus Charon*, De Vis, *Loc. cit.*, p. 15.

*Obs.* Of this animal the portions hitherto discovered consist of a deciduous molar, a femur, radius, and ulna. Mr. De Vis remarks—"In dentition the animal diverges considerably from *Nototherium*, more so from *Diprotodon*; its divergence is towards the Macropodidæ. In its long bones it approaches very closely to *Diprotodon*, possibly to *Nototherium* also. Its thigh-bone shows that it hardly departed from these in the structure and movements of its hind-quarters. It is, in short, a transition form."

The tooth is fourteen lines in length, ten and a-half lines in its anterior and nine lines in its posterior transverse diameter.

*Loc. and Horizon.* Gowrie Creek, Darling Downs (*H. Tryon*—Colln. Queensland Mus.)—Fluviatile deposits.

*Genus—BRACHALLETES, De Vis, 1883.*

(Proc. Linn. Soc. N. S. Wales, viii., Pt. 3, p. 191.)

*BRACHALLETES PALMERI, De Vis.**Brachalletes Palmeri*, De Vis, *Loc. cit.*, p. 191.

*Obs.* Mr. De Vis has lately drawn attention to the great divergence which exists amongst the various genera of Macropodidæ in the "gluteal angle" of the femur. "By gluteal angle is meant the angle made with the long axis of the bone by a straight line touching the top of the trochanter and the summit of the head" of the bone in question. The value of this angle, adds Mr. De Vis, expresses the measure of the leaping ability of the animal.

A femur lately discovered, having the very open gluteal angle of  $77\frac{1}{2}^{\circ}$ , has afforded this Author the opportunity of establishing the above genus, the loss of saltatory power consequent on this open angle quite precluding its reference to any of the more typical genera of Macropodidæ. The femur of *B. Palmeri* was equal in size to that of *Palorchestes azael*, Owen, and not much inferior to *Procoptodon goliath*, Owen. The generic name has reference to the contracted gait of the animal.

*Loc. and Horizon.* Chinchilla, Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Chinchilla Conglomerate.

*Genus—TRICLIS, De Vis, 1888.*

(Proc. Linn. Soc. N. S. Wales, iii. (2), Pt. 1, p. 8.)

*TRICLIS OSCILLANS, De Vis.**Triclis oscillans*, De Vis, *Loc. cit.*, p. 8, t. 1.

*Obs.* Both genus and species are founded on a left mandibular ramus, which seems to indicate an animal allied to a gigantic *Hypsiprymnodon*. Mr. De Vis remarks:—"It would seem that the relations of the extinct animal are complex; capriciously, as it were, its relic yields us glimpses of each of the three families so frequently named [*i.e.*, Phalangeridæ, Pleopodidæ, and Macropodidæ] . . . . Though its affinity to *Hypsiprymnodon* may be said to be paramount, it must be confessed that it is not so to any great extent."

In *Triclis* the lower incisor is followed by a tooth, small in size, but occupying the position of the so-called canine in the Phalangeridæ. In *Hypsiprymnodon*, on the other hand, this tooth is absent.

The name *Triclis* had already been employed by Loew for a genus of Diptera, in 1851.

*Loc. and Horizon.* King's Creek, Darling Downs (*R. Frost*—Colln. Queensland Mus.)—Fluviatile deposits.

*Genus*—*SYNAPTODON*, *De Vis*, 1889.

(Proc. R. Soc. Queensland, v., Part 5, p. 159.)

*Gen. Char.* Molars rooted, antibilophodont, distant at base, in contact by faceted projections fore and aft. (*De Vis*.)

*Obs.* This genus is founded on a fragment of a right lower jaw, says Mr. De Vis, with a nearly perfect cheek-tooth and the half of its adjacent posterior neighbour, which are said in their form and connection to be unique. They abut against each other, not by a basal line of contact, resulting from pressure in the rear as usual, but by means of coadapted processes extending from each end of each tooth, somewhat after the fashion of a vertebral zygapophysis.

*SYNAPTODON AXORUM*, *De Vis*.

*Synaptodon axorum*, *De Vis*, Proc. R. Soc. Queensland, 1889, v., Pt. 5, p. 159.

*Sp. Char.* The perfect tooth is nine millimetres in length, and five millimetres in its greatest breadth. The space between the teeth is nearly equal to the length of each fore lobe. (*De Vis*.)

*Obs.* The general facies of the teeth induced the Author above quoted to consider them as belonging to a new genus of Macropodidæ.

*Loc. and Horizon.* Chinchilla, Darling Downs—(Colln. Queensland Mus.)—Chinchilla Conglomerate.

Family—*DASYURIDÆ*.

*Genus*—*THYLACINUS*, *Temminck*, 1827.

(Mon. Mammologie, I, p. 60.)

*THYLACINUS SPELEUS*, *Owen*.

*Dasyurus lanianus* (para.), *Owen* in Mitchell Three Exped. Int. E. Australia, 1838, ii., p. 363, t. 31, f. 7.

*Thylacinus speleus*, *Owen*, Descrip. Cat. Mam. and Aves R. Coll. Surgeons, 1845, pp. 335-36, Nos. 1548-49.

„ *major*, *Owen*, Extinct Mam. Australia, 1877, p. 106.

„ „ *Lydekker*, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 264.

*Obs.* This species is said to be represented from the Queensland Post-Tertiary Series by part of a right ulna, and axis vertebra in the British Museum (Natural History Branch).

*Loc. and Horizon.* Queensland (Colln. Brit. Mus.)—Fluviatile deposits.

*Genus*—*SARCOPHILUS*, *F. Cuvier*, 1838.

(Hist. Nat. Mam., vii., 70me Livr., p. 2.)

*SARCOPHILUS LANIARIUS*, *Owen*.

*Dasyurus lanianus*, *Owen* in Mitchell Three Exped. Int. E. Australia, 1838, ii., p. 363, t. 31, f. 3-6.

*Sarcophilus lanianus*, *Owen*, Extinct Mam. Australia, 1877, p. 105, t. 5, f. 1-6.

„ „ *Lydekker*, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 265.

*Loc. and Horizon.* Gowrie, Darling Downs (*G. F. Bennett*—Colln. Brit. Mus.)—Fluviatile deposits.

SARCOPHILUS PRIOR, *De Vis*.

*Sarcophilus prior*, De Vis, Proc. Linn. Soc. N. S. Wales, 1883, viii., Pt. 2, p. 189.

*Obs.* The discovery of a portion of a right tibia, with the head preserved, has enabled Mr. De Vis to determine the former presence in Northern Australia of an animal allied to the Tasmanian Devil. The bone gives the impression of a better-knit and more muscular animal, of a size too superior to be included in the same species with *S. ursinus*, one whose last molar must have equalled, or nearly equalled in size, the great sectorial of a large dog.

*Loc. and Horizon.* Darling Downs (*C. W. De Vis*—Colln. Queensland Mus.)—Fluviatile deposits.

Genus—*DASYURUS*, *Geoffroy*, 1796.

(Bull. Soc. Phil. Paris, i., p. 106.)

*DASYURUS VIVERRINUS*, *Shaw*.

*Didelphis viverrinus*, Shaw, Gen. Zool., 1800, i., Pt. 2, p. 433.

*Dasyurus viverrinus*, Waterhouse, Nat. Hist. Mam., 1846, i., p. 442.

" " Krefft, Mam. Australia, 1871, t. 13.

" " Lydekker, Cat. Foss. Mam. Brit. Mus., 1887, Pt. 5, p. 268.

*Obs.* Numerous fragments of the skeleton of the Native Cat have been found in the Wellington Valley Caves, but only one specimen, a nearly entire right mandibular ramus, has been recorded from Queensland.

*Loc. and Horizon.* Gowrie, Darling Downs (*G. F. Bennett*—Colln. Brit. Mus.)—Fluviatile deposits.

## MARSUPIALIA INCERTÆ SEDIS.

Genus—*SCEPARNODON*, *Ramsay*.

(Proc. Linn. Soc. N. S. Wales, 1881, v., Pt. 4, p. 495.)

*SCEPARNODON RAMSAYI*, *Owen*.

*Sceparnodon Ramsayi*, Owen, Phil. Trans., 1884, clxxv., Pt. 1, p. 245, t. 12.

*Obs.* But one species of this genus, and of that only the teeth are known. They resemble the scalpriform incisors of the upper jaw of Rodents, but the microscopic structure of the dentine has a nearer resemblance to that of the incisors of the large extinct *Phascolonus*.

*Sceparnodon Ramsayi* is believed by Prof. Owen to have been a large massive animal, and in all probability marsupial. Mr. Richard Lydekker has recently suggested\* that it is identical with Owen's genus *Phascolonus*; but Mr. De Vis, who has had far better opportunities of studying the question, remarks—" *Phascolonus*, Owen, is demonstrably good; but the ground on which it has been separated—namely, by identification with *Sceparnodon*, a determination so improbable in itself that nothing short of direct proof should suffice to give it currency—appears to me quite inadequate to say the least."† Not only does Mr. De Vis combat the view that the teeth known as *Sceparnodon Ramsayi* "grew in the upper jaw of *Phascolonus*," but he believes that "they include the teeth from both jaws of the otherwise unknown animal."‡ His reasons for this opinion are too lengthy for quotation here, but are well worth perusal by those interested in the question. His final paragraph is—"It must be concluded that both

\* Cat. Foss. Mam. Brit. Mus., Pt. 5, 1887, p. 159; and Proc. R. Soc., xlix., p. 60.

† Proc. Linn. Soc. N. S. Wales, 1891, vi. (2), p. 237.

‡ *Ibid.*, p. 258.

the upper and lower incisors of *Sceparnodon* are known, and, consequently, that *Sceparnodon* is not a synonym of *Phascolonus*." There is much to be said for the bold conception given when defining the Family Nototheridæ—viz., "Probability is also in favour of *Sceparnodon* proving to belong to this family."\*

The geographical range of *Sceparnodon* is a wide one, as teeth have been found in the vicinity of Lake Eyre, South Australia; and in addition to the Queensland locality a number have been found in the rich bone deposit of Myall Creek, near Bingara, N. S. Wales, by Mr. Charles Cullen, Collector to the Geological Survey of N. S. Wales.

*Loc. and Horizon.* King's Creek, Darling Downs (*The late C. H. Hartmann—Colln. Australian Mus.; C. W. De Vis—Colln. Queensland Mus.*)—Fluviatile deposits.

## Order—SIRENIA.

### Family—MANATIDÆ.

*Genus—CHRONOZOON, De Vis, 1883.*

(Proc. Linn. Soc. N.S. Wales, viii., Pt. 3, p. 395.)

*CHRONOZOON AUSTRALE, De Vis.*

*Chronozoon australe, De Vis, Loc. cit., p. 395, t. 17.*

*Obs.* A portion of a skull, consisting of the parietal and upper part of the occipital bones of a non-marsupial animal, has been described by Mr. De Vis, and compared to the corresponding portions of a Dugong.

The chief difference between the fossil and the skull of the Dugong consists in a shallower temporal fossa and feebler muscles for working the jaws.

A mould taken from the interior surface of these bones has enabled the Author to study the brain characters with much success.

The brain was clearly of inferior development to those of existing Sirenians, "and a smoothness of skull indicative of feebler masticating power, may have been the co-adaptation of the softer vegetation and less perilous condition of life enjoyed by a Sirenian tenant of fresh waters."

*Loc. and Horizon.* Chinchilla, Darling Downs (*C. W. De Vis—Colln. Queensland Mus.*)—Fluviatile deposits, associated with Crocodile, Turtles, *Ceratodus*, and the remains of land animals.

## Order—UNGULATA.

### Family—DICOTYLIDÆ.

*Genus—PROCHÆRUS, De Vis, 1886.*

(Proc. R. Soc. Queensland, iii., p. 47.)

*PROCHÆRUS CELER, De Vis.*

*Prochærus celer, De Vis, Loc. cit., p. 47, t. 1.*

*Obs.* The occurrence of various peculiar teeth in the Post-Tertiary Beds of Darling Downs has led Mr. C. W. De Vis to suggest the former presence in Australia of a swine-like animal, more nearly allied to the Peccary (*Dicotyles*) than to the true Pigs. The teeth so determined are a quinque-tuberculate tooth of bunodont type, of the general shape of the last lower molar of *Dicotyles torquatus*, Cuv.; a middle lower

\* Proc. Linn. Soc. N. S. Wales, 1891, vi. (2), p. 164.

incisor of the left side; several second upper incisors, and a portion of the crown of a compressedly triangular tusk. These are described in detail by Mr. De Vis, and compared with their supposed living homologues. On the general question the Author remarks:—"It is truly a remarkable fact that New Guinea swine have never, to our knowledge, accomplished the short passage between the northern and southern shores of Torres Straits, or, having done so, failed to establish themselves where the European pig finds it easy to recover and maintain its independence." He concludes by stating that the comparative frequency of its teeth shows that it was not altogether a rare member of the Post-Pliocene Fauna of Queensland.

*Loc. and Horizon.* Sharrow and other localities, Darling Downs (*C. W. De Vis—Colln. Queensland Mus.*)—Fluviatile deposits.

## Order—PROBOSCIDEA.

### Family—ELEPHANTIDÆ.

*Genus*—*NOTOELEPHAS*, Owen, 1882.

(*Proc. R. Soc.*, xxxiii., p. 448.)

#### *NOTOELEPHAS AUSTRALIS*, Owen.

*Notoelephas australis*, Phil. Trans. 1883, clxxiii., Pt. 3, p. 777, t. 51.

*Obs.* This genus and species were founded on portions of a tusk indicating a mammal larger than *Diprotodon*, in fact the largest fossil mammal yet foreshadowed amongst the extinct Australian forms. Sir Richard Owen appears to regard it as a Proboscidian Placental. He says, "Supposing the dingo to be a human introduction into the Australian Continent,\* we here have a gyrencephalous exception to the characteristic aboriginal mammalian organisation of that remote southern continent." He does not appear to apprehend any connection between this tusk and the molar tooth formerly described by him, and forming a portion of the late Count P. E. de Strzelecki's Collection. Prof. Owen remarks that this molar is too large to be associated with the tusk, supposing the latter to have come from the upper jaw of a full-grown individual of its species. Up to the time of the publication of his "Fossil Mammals of Australia," Owen had received no confirmatory evidence from the Australian Continent of the former existence of any animal to which this molar could have belonged.

Grave doubts have been expressed by several Writers as to the probability of this tooth as an Australian fossil, and it would perhaps be better to expunge it from the list.

*Loc. and Horizon.* Darling Downs (*The late F. N. Isaac*)—Fluviatile deposits.

In closing this very brief and imperfect account of the Post-Tertiary vertebrate remains of Queensland, it may not be out of place to refer to the "Great Bone Beds" of Mount Guthrie, Berserker Ranges, near Rockhampton. From the notes of the late Mr. James Smith, who investigated this deposit, it would appear to be a tufaceous limestone containing the remains of leaves and shells, probably *Helix*, but I have not been able to satisfactorily determine the presence of bones in the specimens I have seen. The matrix very much resembles the Hobart Travertine, but is more friable and stalagmitic, and lighter in colour.

## E.

\* Ample evidence now exists to show that the Dingo was coeval with these extinct marsupials both in New South Wales and Victoria.

## CHAPTER XXXVIII.

### THE GEOLOGY OF BRITISH NEW GUINEA.

Mr. A. Gibb Maitland, of the Geological Survey of Queensland, travelled extensively in New Guinea and the adjacent islands from May to September, 1891, and since his return has made a valuable Report, of which I am enabled, through the kindness of His Honour Sir William Macgregor, to give a brief *résumé*. The Report embodies not only Mr. Maitland's own observations, but also a digest of those of previous observers, and is accompanied by Geological Maps.

Mr. Maitland gives the following table of Geological Formations:—

Recent Superficial Deposits—Wide Plains along the Rivers; Coastal Flats, &c. Coral Reefs, Coral Islands, Upraised Reefs, and associated deposits.

Kevari Grits: Post-Tertiary—Grits, Sandstones, and Conglomerates.

Port Moresby Beds: Tertiary?—Greenish Sandy Shales, Limestones, Calcareo-Siliceous Beds of Port Moresby.

Boioro Limestones, of undetermined age—Greyish Limestones, &c., of Boioro and the Coast.

Metamorphic Rocks, of undetermined age—Schists, Slates, Gneiss, &c.

Igneous Rocks—Basalt and other Volcanic Rocks, Ashes, &c.

Plutonic and Intrusive Rocks—Diorite and other Basic Plutonic Rocks, Granite, Mica-Trap, &c.

#### RECENT SUPERFICIAL DEPOSITS.

Recent Superficial Deposits are represented as commencing on the Southern Coast at the mouth of the Vanapa River, west of Port Moresby, and occupying a belt of country which gradually widens until, at the Dutch Boundary, it covers three out of the four degrees of latitude which comprise the Western limit of the British Possessions.

#### CORAL REEFS, CORAL ISLANDS, UPRAISED REEFS, AND ASSOCIATED DEPOSITS.

The exigencies of rapid travel did not permit Mr. Maitland to examine any of the existing coral reefs, but opportunities occurred of observing many of the upraised reef masses, especially at Einauro (Cette) Island, Ware (Teste) Island, the Bell Rock, Pannietta Island, Kimuta (Renard) Island, Misima (St. Aignan) Island, and along the north-east coast. The latter present "all gradations, from reefs only a few feet above the water up to two thousand feet above the level of the sea."

Mr. Maitland gives the following description of the upraised reefs:—

"The rocks present pretty much the same lithological characters throughout—viz., very hard and sonorous compact limestones, of a whitish colour. Some varieties are of a distinct yellow or reddish-brown colour. Coral fragments do not appear to be very common; but in some of the upraised reefs molluscan remains are by no means rare. The limestones, in the majority of instances, are seamed with veinlets of carbonate of lime.

"Generally the structure of the coral has been destroyed by the action of infiltrating water. Instances, however, do occur—*e.g.*, at Misima—in which this is not the case.



Here the base of one of the upraised reef masses consists of a chalky limestone, in which the remains of corals still exist. In most of the islands and localities examined, these elevated reef masses, when viewed at a distance, present the appearance of vertical walls and level terraces stretching often for considerable distances. The faces of these cliffs are sometimes covered with vegetation to such an extent as to present the appearance of consisting of a huge wall of foliage.

"The reefs raised only a few feet above the sea level, such as those of Pan-nietta, present, along the shore, a white perpendicular cliff, of varying height, above which is an almost level tableland, very broken and rugged, and with a very uneven surface.

"Gigantic 'swallow-holes' and enormous caves have been carved out of some of the limestones, and are lined with stalagmites and stalactites. The faces of the limestone cliffs are weathered into most rugged and sharp-edged forms, often presenting features of great beauty.

"In the majority of cases which came under my notice, the various limestone terraces were horizontal, but at Ware (Teste) Island a marked peculiarity of the reef limestones was their disposal into a series of gentle folds, the axes of which trended, roughly, north and south. In Einauro (Cette) Island, the cream-coloured limestone had a dip of 50 degrees to the west-north-west."

As the collection of fossils from the upraised reefs has not yet been critically examined, no definite information can be given regarding the age of the deposits. I may remark, however, that there is nothing in the evidence accumulated by Mr. Maitland to warrant an inference which might be hastily drawn from the position occupied by the upraised reefs on his scale of classification—viz., that the elevation—extending to at least two thousand feet—attested by the altitudes attained by the reefs, took place entirely since Tertiary times. The process of elevation may have been going on continuously from a period much further back in the geological story. Indeed the comparatively unimportant altitudes attained by Tertiary rocks may be taken as evidence (however incomplete, and to some extent merely of negative value) that the position of these latter rocks forms a measure of the elevation accomplished since Tertiary times.

#### KEVORI GRITS: POST-TERTIARY.

Under this name Mr. Maitland describes a Series of Sandstones, Grits, and Conglomerates, which, in the Kevori District, north-west of Hall Sound, rest directly upon the Port Moresby Beds. The strata in question have been little disturbed from their original horizontal position, but in places they dip at a low angle to the north-east. Mr. Maitland observes:—"That the Kevori Grits are younger than those which have been called the Port Moresby Beds, and which are regarded by Mr. R. Etheridge, Junr., as being Miocene \* or Pliocene Tertiary, is all that the meagre evidence at present collected permits us to say."

#### PORT MORESBY BEDS: TERTIARY.

These beds occupy a considerable area of country, fringing the coast from Caution Bay south-eastward to McFarlane Harbour, and extending inland for about twenty miles up the Kemp-Welch River. They consist of sandy limestones and fine-grained calcareous shales, with black and yellow lenticular nodules of flint and chalcedony, and are generally vertical, or inclined at high angles.

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\* A Miocene age was ascribed to these fossils by the late Mr. C. S. Wilkinson, not by me. I am in accord with the late Rev. J. E. T. Woods, as explained later on, that these fossils are much more likely to be of Pliocene age, and probably even to one of the younger divisions of that Formation. (R.E. Junr.)

From these beds Mr. Maitland obtained a suite of fossils, which, however, have not yet been critically examined, but he provisionally names the following :—

GASTEROPODA.

*Conus.*

*Turritella.*

LAMELLIBRANCHIATA.

*Cardita.*

*Pecten novæ-guinæ*, Ten. Woods?

*Pectunculus.*

*Venus.*

And fragments of undeterminable corals.

CRETACEOUS.

Mr. Maitland does not locate on his Geological Maps, nor does he find a place in his table of formations for the strata containing the Cretaceous fossils referred to by the late Mr. C. S. Wilkinson and my Colleague,\* although he quotes from the writings of both these gentlemen on the subject. The fossils in question, together with a further collection forwarded by the Administrator in the beginning of 1890,† are enclosed in water-worn boulders and pebbles of white limestone occurring above the confluence of the Strickland with the Fly River. They do not appear to have been found *in situ*. The last-mentioned collection consists mainly of corals. As my Colleague comments fully on the Fly River fossils, it is unnecessary for me to say more.

BOIORO LIMESTONES (AGE UNDETERMINED).

"What have been called the Boioro Limestones are best exposed in that headland in Launoka Division (Mayri Bay) from which the beds are named.

"At Boioro, the limestones are of a leaden-grey colour, and are seamed with veinlets of carbonate of lime. The weathered surfaces present a curious brecciated aspect. The bedding-planes, marked by lines of brecciated fragments (?), are inclined to the north-west, at angles varying from 35° to 40°. Some of the limestones contain flint nodules; in some places there is a gradual passage from limestone into flint. A dyke of dolerite was seen to penetrate the limestones in the cliffs of Boioro.

"On the very feeble evidence of lithological similarity, the limestones of Rogea (Heath) Island, and the Mainland north of Samarai, in the vicinity of Waiera Creek, are denoted by the same colour as those of Boioro. The Rogea Limestones are arranged in thin beds in a small synclinal trough. The limestones of the Mainland are identical in every way with those of Rogea. In neither place did they yield any organic remains.

"The limestones of the Mainland are penetrated by dykes of dolerite, and sections show what have every appearance of being interbedded dolerite sheets.

"There is no evidence as to the age of the beds. From their position they appear, *primâ facie*, to be beneath the Port Moresby Beds, and they present totally different lithological characters to those possessed by the latter. They are unconformably overlaid by the Recent Volcanic Rocks."

Referring, in a foot-note, to the Boioro Limestones of Mayri Bay and Port Glasgow, Mr. Maitland suggests that the limestones "may be merely portions of an upraised coral reef," and observes that "the adjacent island of Cetta is obviously of this nature."

\* The only fossil referred to by me as *perhaps* of Cretaceous age is an *Inoceramus* or *Aucella*, the great bulk of the secondary fossils (Ammonites) being regarded as of uppermost Oolite age. (*R.E. Junr.*)

† Letter dated 6th May, 1890, from the Writer to the Administrator of the Government of British New Guinea. *Appx. Z. to the Administrator's Annual Report for 1890-91.* Brisbane: by Authority: 1892.

From what has already been said regarding the age of the upheaval of the coral reefs, it will be seen that there is not necessarily anything in Mr. Maitland's suggestion inconsistent with the assignment of an early Tertiary, or Pre-Tertiary, date to the Boioro Limestones.

From observations made by Mr. Maitland at Millport Harbour, it is evident that the Boioro Limestones have a thickness of at least 800 feet.

#### METAMORPHIC ROCKS.

The approximate definition of the area occupied by these rocks, in which, and the granitic and other plutonic rocks, deposits of the "precious" and less precious metals may be looked for, is, from an economic point of view, one of the most important results of Mr. Maitland's observations.

The Metamorphic Rocks are separable, according to Mr. Maitland, into two broad subdivisions. "The first includes what may be called the crystalline schists, and the second comprises all those other rocks in which the alteration has not gone sufficiently far to conceal their clastic or derivative nature. To draw a line separating the two divisions is quite impossible at present."

An immense area, extending for a few miles back from Port Moresby, nearly to the 8th parallel of South Latitude (the German Boundary) is occupied by Metamorphic rocks. Another large area occurs on the Mainland to the east, at Mount Suckling. Although unexplored, the greater part of the intervening district, and indeed probably the greater part of the highland interior of New Guinea, may be conjectured to be of similar constitution. The islands of the D'Entrecasteaux and Louisiade Groups, several of which are known to be auriferous, are also mainly composed of metamorphic rocks. It will remain for future geologists to determine whether, among these rocks, the representatives of our "Gympie" and "Burdekin" Formations, and of the still older formations not yet recognised in Queensland, are to be distinguished.

#### IGNEOUS ROCKS.

From Mr. Maitland's Maps it appears that volcanic rocks are met with at intervals from the Douglas River (Long.  $144^{\circ} 15' E.$ ) to the Eastern end of New Guinea and throughout the D'Entrecasteaux Islands, where they occupy considerable areas. In the Louisiade Archipelago they seem to occur more sparingly, or, at least, they have not been noted east of Long.  $152^{\circ} 40'$ , where they form some of the smaller islands of the group. Mr. Maitland says that "the Volcanic rocks fall into two primary divisions, the Acidic Series and the Basic Series, the former of which appears to predominate. Representatives of the Trachytic, Andesitic, and Basaltic lavas, with their associated fragmental beds, were met with throughout the Possession. From the fact that these rocks rest, with a violent unconformability, on the most recent strata, they cannot be of any very great age."

Interesting particulars are recorded of some forms of modified volcanic activity in the D'Entrecasteaux Islands and the Mainland of New Guinea.

In Fergusson Island, the largest of the D'Entrecasteaux Group, Captain Moresby, Mr. Andrew Goldie, Mr. Basil H. Thompson, and Sir William Macgregor have noted the occurrence of thermal springs. Sir William records that "the whole of the low country near Seymour Bay contains, here and there, over an area of, perhaps, eight or ten square miles, boiling springs, saline lakes, and thousands of fumaroles, giving out sulphur fumes." Mr. Thompson describes "springs of boiling water and boiling mud," and adds that "in one instance boiling mud was spouted up from a chimney-like cavity in the hillside."

In Fergusson Island (Moratau)\* Mr. Maitland ascended the Crater of Dian, 900 feet. "The ascent was made up a gully carved out of a blackish ash, with fragments of pumice-stone and a glassy volcanic rock. From the summit an excellent view of the cone and its associations could be obtained. This is a tuff cone. Its south-eastern face is hollowed out into numerous ravines, in which occasional sections show stratified ashes. The crater wall has been breached by a lava, which flowed to within a short distance of the beach, near Worua Island. I followed the edge of the lava-flow from its source to its termination, and was enabled to ascertain that its general character is similar throughout. The rock has a glassy resinous lustre and a splintery fracture. Weathered surfaces show undoubted fluxion-structure, the lines of flow sweeping round the sanidine crystals, sanidine being the only mineral visible to the eye. From the summit of the crater the emanation of water-vapour could be seen over a large area of country to the north."

In referring to the small bay in Fergusson Island, to the north-west of Rawai Point, Mr. Maitland observes that "its peculiar scythe-shaped form pointed to its being the segment of an ancient crater, and an actual examination gave credence to this view. Manifestations of solfataric action were evident on the face of the cliff. . . . In places the sea water was quite hot, owing to the streams of hot water which flowed down from the hills behind."

Mr. Maitland describes two visits made by him to the island of Dobu (Goulvain), south of Fergusson Island, as follows:—

"Approaching Dobu from Dawson Straits, it appeared to have all the characteristics of a volcano. Steam could be seen issuing from points on the beach on the north side of the island.

"My first visit was paid at about the time of high water. There were several orifices from which water issued at an average temperature of 200° Fahr. I estimated the area over which the waters issued at about one hundred square yards. The gas, given out copiously, had a strong sulphurous odour. The sandstones in the neighbourhood were slightly bleached.

"A second visit, at low water, showed that the so-called boiling springs were merely fissures to which sea water had access. The sides of the fissures were encrusted with deposits of flowers of sulphur. A few yards behind the fumaroles was a whitish-grey cliff, exhibiting undoubted evidences of solfataric action. In caverns in the cliffs there occur large deposits of yellow and greyish-brown sulphur, commonly massive, but here and there in the form of acicular crystals. These caverns, many of which I discovered when breaking down the cliffs with my hammer, were found to have a very high temperature. In one case a stream of hot air rushed out with a hissing noise, but this was only momentary."

In the same island there are two extinct craters, which must be of considerable proportions, for Mr. Maitland mentions that "a few villages" have been built on the "lofty almost circular wall, roughly estimated at about a hundred feet in height," of one of them.

Mr. Maitland got sufficiently near the active volcano of Mount Victory (on the north-east coast of New Guinea), to see volumes of steam and smoke issuing from the sides of the mountain.

#### PLUTONIC AND INTRUSIVE ROCKS.

The area occupied by granitic rocks is apparently not large. So far as exploration has extended, it has only been noted in the Mainland at Mabadian, north of Sabai Island, and in a few of the islets of Torres Strait. Diorites and other basic rocks, which Mr. Maitland regards as either Plutonic or Intrusive, are met with in limited areas in the Owen Stanley District.

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\* In the 1890 Map the name Moratau is applied to Goodenough Island, west of Fergusson Island.

## ECONOMIC GEOLOGY

*Gold*.—Alluvial gold has been worked in the Islands of Saint Aignan and Sudest, and is known to exist also in Normanby Island, in the Vanapa River, and in the Saint Joseph District. In Normanby Island the gold is associated with cinnabar. Reefs are worked on a small scale in Sudest Island, and have been noted in Normanby Island. In the years 1888 to 1891, inclusive, 8,399 oz. of gold, valued at £34,310, have been reported to the Customs at Cooktown, from New Guinea.\*

*Sulphur*.—Native sulphur occurs in Fergusson and Goulvain Islands, in the D'Entrecasteaux Group.

*Lignite*.—Seams of lignite are known in Yaru Island, and on the Fly and Strickland Rivers.

*Mercury*.—Cinnabar has been found in small quantities at Merani, in Cloudy Bay, and in Normanby Island.

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\* "That gold exists in the western and northern portions of New Guinea has long been known; that it exists also on the south-eastern shores of that great island is equally true, as a specimen of pottery procured at Redscar Bay contained a few laminar grains of this precious metal. The clay in which the gold is imbedded was probably part of the great alluvial deposit on the banks of the rivers, the mouths of which we saw in that neighbourhood, doubtless originating in the high mountains behind, part of the Owen Stanley Range."—MacGillivray. *Narr. Voyage of H.M.S. "Rattlesnake," &c., 1852*, ii, p. 69.

## CHAPTER XXXIX.

### PALÆONTOLOGY OF BRITISH NEW GUINEA.

As might naturally be expected, but little is known of the Palæontology of New Guinea. The existence of fossiliferous Tertiary rocks was announced in 1876, by the late Mr. C. S. Wilkinson, who based his determination on a small collection made by the late Sir William Macleay, at Yule Island, during the "Chevert" Expedition. Post-Tertiary deposits were shown to exist by the late M. de Miklouho-Maclay, on the Maclay coast; and since then shells of the same age have been met with at the Aird Hills, Douglas River, by Mr. Theodore Bevan.

Rocks of Mesozoic age exist in New Guinea, as evidenced by Ammonites brought from the Strickland River by the late Expedition of the Australian Geographical Society. Although these are only rolled specimens from the river-bed, they satisfactorily show the presence there of deposits of Oolite age, probably about the horizon of the uppermost Oolites. Lastly,\* my Colleague's Collection contains a few Tertiary Corals and Mollusca from Maiva, collected by Mr. E. Edelfelt.

### DESCRIPTION OF THE SPECIES.

#### Kingdom—ANIMALIA.

#### Sub-Kingdom—CŒLEENTERATA.

#### Class—ACTINOZOA.

The Collection of the Queensland Geological Survey has been enriched by the presentation of some hand specimens of a brownish-yellow marl, by Mr. E. Edelfelt, from New Guinea. This marl has plentifully scattered through it the remains of small shells in the form of casts and a few fragments of corals. The locality is Maiva Village, at a height of about two hundred feet above the sea-level. Although these fossils are very fragmentary, "any Tertiary Marine remains from the Pacific are of high interest, because of their bearing on the coral reef theory."†

The most striking of the corals is a species of *Alveopora*, allied to those described by Dr. A. E. Reuss from the Tertiary Beds of the Tiji-Lanang Valley, Rongga District, Java.‡ The trabecular septa are strong and spine-like, much curved, and six or perhaps more in a cycle. They have this peculiarity, that they appear to be developed in pairs—a character to some extent seen in Reuss' specimens, but in the present fossils carried to a much higher degree. The spurious columella formed by the union of the septa is of the slightest construction. In the character of the septa this coral appears

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\* Sir William MacGregor, Administrator of British New Guinea, has forwarded a collection of rolled coral specimens from the Fly River, evidently brought down the course of that stream from its upper sources, where, doubtless, the rocks from which these are derived are in place. Many of the corals present excellent material for microscopic examination, but the absence of the necessary works of reference for their elaboration has so far prevented the Writer from progressing with the work.

† Tenison Woods, Proc. Linn. Soc. N. S. Wales, 1879, iv., p. 539.

‡ Ueber fossile Korallen von des Insel Java. *Reise Osterr. Fregatte Novara*, 1857-59. *Geol. Thid.* ii. Band, 2 Abth., p. 165.

to be most nearly allied to *Alveopora brevispina*, Reuss,\* but in the other features to *A. hystrix*, Reuss.† If the paired condition of the septa, here so very marked, is a constant and definite character, and it appears to be so, it will at once distinguish this coral from all those described by Dr. Reuss.

The largest and best-preserved coral is a species of *Leptoria*, a genus not met with either by Reuss amongst the Javan corals, nor by Prof. K. Von Fritsch,‡ amongst those collected in Borneo by Mr. R. D. M. Verbeek. On the other hand, Prof. K. Martin, of Leiden, describes § an allied genus, *Cæloria*, from the former country. The characters of the New Guinea *Leptoria*, as portrayed in the single specimen, are not sufficiently clear for specific description, and make one long for further material. *Leptoria* is extensively distributed in the Indian and Pacific Oceans.

Next in order is a well-marked *Galaxea*, again only a fragment, but clearly not far removed from the recent *G. clavis*. The corallum, as preserved, is split in half longitudinally, and exhibits several corallites radiating outwards and surrounded by a copious peritheca.

The last to be noted, but certainly not the least important, are two examples, fragmentary unfortunately, of the interesting genus *Deltocyathus*, distinct both from the Tertiary and Recent species *D. italicus*, Ed. and H., and the recent *D. magnificus*, Mosely. The occurrence of this genus in these New Guinea beds is of the highest interest, following as it does upon its discovery by the "Challenger" Expedition in the Pacific.||

The material presented by Mr. Edelfelt to the Queensland Survey Collection is of too limited a nature to permit any definite statement to be made as to the age of the beds, but they are either Younger Miocene or Pliocene, probably the latter. The Javan series described by both Reuss and Professor Martin are considered by the latter to be of Miocene age.¶

## Sub-kingdom—ECHINODERMATA.

### Class—ECHINOIDEA.

### Order—ENDOCYCLICA.

### Family—TEMNOPLEURIDÆ.

### Genus—*TEMNECHINUS*, Forbes, 1852.

Mon. Brit. Tertiary Echini, p. 5.)

### *TEMNECHINUS MACLEAYANA*, Ten. Woods.

*Temnechinus Macleayana*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1877, ii., Pt. 2, p. 126.

*Sp. Char.* Test small, depressed, circular, and the ambitus rounded; actinal surface slightly rounded and depressed to the actinostome; interambulacral areas twice the width of the ambulacral at the ambitus, and about one-third broader at the mouth, slightly depressed in the middle by an undulating line of suture, which

\* Loc. cit., t. 3, f. 7 a-c.

† Ibid., t. 3, f. 8 a-c.

‡ Fossile Korallen der Nummulitenschichten von Borneo. *Palæontographica*, Suppl. 1878. Band. iii. Lief. 1, Heft. 3, p. 93.)

§ Die Tertiärschichten auf Java, 2 Thiel., p. 137 (folio, Leyden, 1880).

|| Report on certain Hydroid, Alcyonarian, and Madreporarian Corals, &c., by Prof. Mosely. *Voy Challenger*, vol. ii., *Zoology*, 1881, pp. 147 and 148.

¶ Loc. cit., 2 Thiel, p. 38,

becomes a very distinct depression on the abactinal surface, on which the line of the plates are well marked; pores in a vertical row, slightly oblique, and their zones sunken. Interambulacra have two rows of primary tubercles, each row being flanked again on each side by a vertical row of secondaries, all small and imperforate, both primaries and secondaries surrounded by circles of granular tubercles, which are frequently connected with the main tubercle by a ridge. Primaries of the ambulacra in two vertical rows, each close to its poriferous zone; secondaries not so visible, but the rings of granules are very manifest, with an indented vertical line of suture in the centre. Actinal opening larger, with conspicuous but not deep indentations. Diameter, sixteen; altitude, six millim. (*Ten. Woods.*)

*Obs.* Mr. Woods appears to consider this near the *Temnechinus lineatus*, Duncan,\* from the Mordialloc beds, Hobson's Bay, but, again, he adds—"The nearest affinities are *T. globosus*, of the British Crag." The species is provisionally named only.

*Loc. and Horizon.* Yule Island, New Guinea (*The late Sir W. Macleay*—Macleay Museum, University of Sydney)—Lower Pliocene?

### Family—LAGANIDÆ.

*Genus*—*PERONELLA*, Gray, 1855.

(Cat. Recent Echini Brit. Mus., Pt. 1, 1855, p. 13.)

*PERONELLA DECAGONALIS*, Lesson, sp.

*Peronella decagonalis* (Lesson), Agassiz, Revision (Echini Ill. Cat. Mus. Comp. Zool. Harvard Coll., 1872, No. vii., Pts. 1 and 2, p. 148.

„ „ Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1877, ii., Pt. 2, p. 126.

*Obs.* This has been recognised by the late Rev. J. E. Tenison Woods as a fossil from Yule Island, New Guinea. He says—"The specimens, two in number, are extremely thin and concave on the actinal side, but they are both young specimens, and one scarcely above an inch in diameter."

*Loc and Horizon.* Yule Island, New Guinea (*The late Sir W. Macleay*—Macleay Museum, University of Sydney)—Lower Pliocene?

## Sub-Kingdom—MOLLUSCA.

### Class—PELECYPODA.

### Order—OSTRACEA.

### Family—PECTINIDÆ.

*Genus*—*PECTEN*, O. F. Müller, 1776.

(Zool. Danicæ Prod., p. xxxi.)

*PECTEN NOVE-GUINEÆ*, *Ten. Woods.*

*Pecten nove-guineæ*, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1877, ii., Pt. 3, p. 267.

*Sp. Char.* Shell regularly orbicular, equivalve, regularly convex, but not globose, equilateral, and symmetrically rounded at the margin; ears quite square, one being a little obliquely indented at the edge, but otherwise almost equal, and rather large, and with from eight to ten very granular ribs; surface with from twelve to

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\* Quart. Journ. Geol. Soc., 1877, xxxiii., pp. 46 and 65, t. 3, f. 3-5.



fourteen large rounded radiate ribs; each with two rather shallow radiate grooves and transversely striate, striæ at the marginal end becoming scaly raised imbrications, eight to ten in number; interstices furnished with two or three conspicuous granular ribs; umbone very acute; Long. 60, Lat. 50, thickness of two valves 30 millim. (*Ten. Woods.*)

*Obs.* This shell is said by its describer to have relations with *Pecten asper*, of South Australia, the common Australian *P. bifrons*, and *P. radula*, Linn., from the Philippine Islands, but to be distinct from all.

*Loc. and Horizon.* Yulo Island (*The late Sir W. Macleay*—Macleay Museum, University of Sydney)—Lower Pliocene?

## Order—VENERACEA.

### Family—CYRENIDÆ.

*Genus—CYRENA, Lamarck, 1806.*

(Ann. Mus. Hist. Nat. Paris, vii.)

*CYRENA NITIDA, Deshayes.*

*Cyrena nitida*, Deshayes, Proc. Zool. Soc., 1854, p. 23.

„ „ Canefri, Ann. Mus. Civ. Storia Nat. Genova, 1883, xix., p. 236.

*Obs.* This species is reported from the Aru Islands, by Canefri; and he quotes New Guinea, on the authority of Beccari.

*Loc. and Horizon.* Aird Hills, Douglas River, British New Guinea. This species, with *Melania clavus*, Lamarck, and *Neritina gagates*, Lamarck, was collected by Mr. T. F. Bevan during his Fifth Exploring Expedition to British New Guinea. He says—"The term Aird Hills describes an island of probably moderately recent upheaval, on which a cluster of volcanic cones, some ten in number, and covering an area of about five square miles, are surrounded by deep navigable channels of fresh water. The country for thirty miles to the south, and for some ten miles to the north, is chiefly of low-lying alluvial formation. The general form of these trachyte hills is a volcanic cone. The summit of this particular cone, however, is covered with a deposit of semi-fossilised fluviatile shells, contained in an earthy mould or silty mud."\*

## Class—GASTEROPODA.

### Order—PECTINIBRANCHIATA.

#### Family—MELANIDÆ.

*Genus—MELANIA, Lamarck, 1801.*

(Syst. Anim. sans Vertéb., p. 91.)

*MELANIA CLAVUS, Lamarck.*

*Melania clavus*, Lamarck, Loc. cit., 1822, vi., Pt. 2, p. 165.

„ „ Brot, in Kuster's Syst. Conch.—Cabinet, 1874, Melaniaceen, p. 175, t. 21, f. 17 a-c.

*Obs.* Mr. J. Brazier informs me that this species has been met with in the Solomon Islands, but not before in New Guinea.

*Loc. and Horizon.* With the preceding.

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\* Mr. T. F. Bevan's Fifth Expedition to British New Guinea, 1888, pp. 21-22 (8vo.: Sydney: by Authority: 1888).

## Family—DOLIIDÆ.

*Genus—DOLIUM, Lamarck, 1801.**Syst. Anim. sans Vertèb., p. 79).**DOLIUM COSTATUM, Deshayes.**Dolium costatum*, Deshayes, in Lamarck Hist. Nat. Anim. sans Vertèb., Ed. 2, 1844, ix., p. 144.

,, ,, Ten. Woods, Proc. Linn. Soc. N. S. Wales, 1878, ii., Pt. 3, p. 268.

*Obs.* Characteristic casts of this species have been recorded by the late Rev. J. E. Tenison Woods from the New Guinea Tertiary strata. He remarks—"There is no other species known to me which has the peculiar sub-acute distant ribs, and decidedly canaliculate suture, all of which, as well as the corresponding shape, are well shown in the cast in Mr. Macleay's Museum."

These casts are accompanied by others of a *Phos*, and *Strombus novæ-zealandiæ*.

*Loc. and Horizon.* Yule Island, New Guinea (*The late Sir W. Macleay—Macleay Museum, University of Sydney*)—Lower Pliocene?

## Family—NERITIDÆ.

*Genus—NERITINA, Fleming, 1828.**(Brit. Animals, p. 321.)**NERITINA GAGATES, Lamarck.**Neritina gagates*, Lamk., Hist. Anim. sans Vertèb., 1822, vi., Pt. 2, p. 185.,, ,, Reeve, Conch. Icon. (*Mon. Neritina*), 1855, t. 10, f. 47.

,, ,, Brazier, Proc. Linn. Soc. N. S. Wales, 18 ii., p. 21.

,, ,, Canefri, Ann. Mus. Civ. Storia Nat. Genova, 1883, xix., p. 66.

*Obs.* This species was obtained in the living state by Mr. J. Brazier at the Katau River, in the "Chevert" Expedition.

*Loc. and Horizon.* Aird Hills, Douglas River (*T. F. Bevan—Mining and Geol. Museum, Sydney*)—Post-Tertiary.

A very interesting Paper on the Geology of New Guinea was a few years ago contributed by the late Mr. C. S. Wilkinson, Government Geologist of N. S. Wales, "Notes on a Collection of Geological Specimens collected by William Macleay, Esqr., &c., from the Coasts of New Guinea, &c."\* Amongst these were—

1. Oolitic limestone from Bramble Bay.
2. Yellow calcareous clay from the Katau River.
3. Yellow and blue calcareous clays from Yule Island and Hall's Sound.

The included fossils led Mr. Wilkinson to regard these clays as of Lower Miocene age, and "exactly similar in lithological character to the Lower Miocene beds near Geelong, and on the Cape Otway coast in Victoria."

The larger number of fossils were obtained at Hall's Sound, and in the condition of casts, but the only two specifically determined were—

*Voluta macroperta, McCoy*,, *anticingulata, McCoy.*

The evidence for assigning a Miocene age to these beds seems to be anything but conclusive. The deposit at Yule Island is a calcareous concrete, composed of Shells,

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\* Proc. Linn. Soc. N. S. Wales, 1877, i., Pt. 2, p. 113.

Corals, and Echini. These are probably the species referred to in previous pages from Yule Island, and described by the Rev. J. E. Tenison Woods in two papers, "On a Tertiary Formation at New Guinea"\* and "On some Tertiary Fossils from New Guinea."† He considers these deposits not as old as the Murray River Tertiaries, or those of Cape Otway in Victoria, or Mount Gambier in South Australia. Although this is clearly a criticism of the previously published view of Mr. C. S. Wilkinson, that the New Guinea fossils are referable to the Lower Miocene, no mention whatever is made of that gentleman's paper on the subject.

In addition to the shells first described, the late M. de Miklouho-Maclay collected no less than thirty-eight species of Mollusca from a greenish sandy clay forming the nearest hills to the coast line, at the Village of Bongu, Maclay coast.‡

The specimens were determined by Mr. John Brazier, who states § that they all belong to species at present living in the China Sea, in Torres Strait, and around the Philippine Islands. The following is a list of his determinations:—

*Ranella albivaricosa*, Reeve  
*Nassa liquijarensis*, A. Adams  
*Nassa*, sp. ?  
*Mitra*, sp. ?  
*Oliva neostina*, Duclos  
*Oliva sidella*, Duclos  
*Oliva*, sp. ?  
*Oliva lepida*, Duclos  
*Oliva ispidula*, Sowerby  
*Oliva*, sp.  
*Oliva*, sp.  
*Terebra straminea*, Gray  
*Conus (Dendroconus) glaucus*, Linn.  
*Strombus canarium*, Linn.  
*Bulla ampulla*, Linn.  
*Atys cylindrica*, A. Adams  
*Atys cylindrica*, var. *elongata*, A. Adams  
*Atys*, sp. ?  
*Dentalium longirostrum*, Reeve

*Cultellus*, sp. ?  
*Corbula crassa*, Hinds  
*Corbula albuginosa*, Hinds  
*Maetra*, sp. ?  
*Tellina (Tellinella) McAndrewi*, Sowerby  
*Tellina (Arcopagia) pinguis*, Hanley  
*Tellina (Phylloda) foliacea*, Linn.  
*Tellina (Angulus)*, sp. ?  
*Tellina (Tellinides)*, sp. ?  
*Tellina (Peronæa) scalpellum*, Hanley  
*Tellina (Strigella)*, sp. ?  
*Tellina (Metis) spectabilis*, Hanley  
*Venus (Chione) calophylla*, Phillipi  
*Venus (Chione) imbricata*, Sowerby  
*Dione bullata*, Sowerby, sp.  
*Dosinia canaliculata*, Sowerby, sp.  
*Leda pullata*, Sowerby  
*Arca*, sp. ?

In the "Records of the Geological Survey of New South Wales" || I contributed a paper "On our Present Knowledge of the Palæontology of New Guinea," from which the following extract ¶ is taken, bringing the history of the subject up to date:—

During the comparatively recent Expedition to New Guinea in 1885, fitted out by the Royal Geographical Society of Australasia,\*\* a few fossils were obtained which next claim our attention. From the head of the Strickland River an olive-green mudstone was obtained, full of comminuted marine fossils, chiefly mollusca. The lithological character of the matrix points to volcanic origin. None of the species were nameable.

From the first foot-hills of the Upper Strickland River a block of fine sandstone containing *Pecten* was obtained. This, Mr. A. J. Vogan, who was attached

\* Proc. Linn. Soc. N. S. Wales, 1878, ii., p. 125.

† *Ibid.*, p. 267.

‡ *Ibid.*, 1885, ix., Pt. 4, p. 963.

§ *Ibid.*, p. 988.

|| Vol. i., Pt. 3, 1889, pp. 172-179, Pl. 29.

¶ P. 174.

\*\* Special Record of the Arrangements of the Exploration of New Guinea. *Proc. Geogr. Soc. Australasia, Special Vol.*, 1885, p. 157. .

to the Expedition, informed me *was in situ*. The shells are too much worn by weathering to attempt a specific determination, but they seem to have more of a Tertiary than a Secondary aspect.

At Observatory Bend, Strickland River, numerous travelled nodules and small boulders were collected, revealing a totally different kind of life, chiefly the remains of Ammonites. But amongst them is a bivalve, either an *Ancella* or an *Inoceramus*. If the latter, it is decidedly of the type of the Cretaceous *I. concentricus*. Unfortunately, the characters of the hinge cannot be ascertained. These fossils are, however, of little importance when compared with the Ammonites. Out of a number of nodules, in which the fossils are indicated by impressions or casts, a fairly representative series has been selected, containing four more or less recognisable species, or at any rate species which can be referred to one or other of the sections into which the old genus *Ammonites* is now broken up, and the facies of which is sufficiently clear for broad generalisation.

The section *Stephanoceras* is largely represented by an Ammonite of the group of *A. callorensis*, Sby., and even closely allied to that species. At first sight the primary costæ springing from the umbilical margin are not very apparent in our specimens, but attentive examination reveals them as in D'Orbigny's figure\* of this species, but closer together, and therefore more numerous. It would appear that the umbilicus is smaller than in the European form, and less telescopic, wherein these shells approach *Stephanoceras transiens*, Waagen,† from Kutch, or *S. maya*, J. de C. Sby.‡ They possess the same form and arrangement of ribs as in the latter, which commence quite simple at the umbilicus, and break up at about equal distances into bundles of three, whilst the shell is rather more compressed.

The next species partakes of the form of *Stephanoceras Blagdeni*, J. Sby., or equally well with *S. coronatus*, Brug. It is a small shell, with the costæ of the back and the tubercles less marked than in the above species. On the other hand, the cross-section of the whorls clearly indicates its relation to this group. The specimen also partakes, in some degree, of the features of the shell figured by D'Orbigny as *Ammonites Humphresianus*; § but the umbilicus in the former is deeper. A comparison may also be made with Quenstedt's figure of *S. coronatus*||.

Two rather well-marked Ammonites appertain to the group *Stephanoceras lamellosum*, J. de C. Sowerby,¶ but, as compared with that species, possess a wider and more open umbilicus, with the costæ of the back less upwardly curved and more horizontal; in fact, the costæ are all more direct, and lack the sigmoidal curve on the flanks of *S. lamellosum*. From *S. Grantianum*, Oppel, as figured by Waagen, the costæ seem to be finer, but to J. de C. Sowerby's figure of this species, under the name of *A. Herveyi*,\*\* our fossils bear a close resemblance, and also to D'Orbigny's figure†† of the same, in the breadth and nature of the back. An affinity is also to be detected in the same Author's *Ammonites macrocephalus*,‡‡ but not with that of Waagen under the same name. A third fragment, however, possesses costæ as coarse as those shown in the latter's illustration of *Stephanoceras Grantianum*.

\* Pal. Franç. Terr. Jur. Ceph., i., Atlas, t. 162, f. 10.

† Pal. Indica (Jurassic Fauna of Kutch), i. Ceph., t. 32, f. 2a.

‡ Trans. Geol. Soc., v. (2), t. 61, f. 8.

§ Pal. Franç. Terr. Jur. Ceph., i., Atlas, t. 134.

|| Cephalopoden, 1849, Atlas, t. 14, f. 4a.

¶ Trans. Geol. Soc., v. (2) t. 23, f. 8.

\*\* Trans. Geol. Soc., v. (2), t. 23, f. 5.

†† Pal. Franç. Terr. Jur. Ceph., i., Atlas, t. 150.

‡‡ Pal. Franç. Ter. Jur. Ceph., i., Atlas, t. 151.

Yet another Ammonite, which Dr. H. Woodward—who was kind enough to examine casts of all these fossils sent him by myself—compares to *A. lingulatus*, Quenst., of the White Jura. Figures of this species are not accessible to me, and I cannot find anything precisely like it, although it seems to be of the Upper Oolite type of *A. Lamberti*, Sby., and *A. Sutherlandiæ*, Sby., as figured by D'Orbigny,\* in so far as the break in the double costation goes, but the back of our shell is much too broad and the costæ too fine. The square back, with its oblique costæ, and the marginal crenulations, all convey to this shell a much more Upper Oolite or Lower Cretaceous aspect than they give to it a Lower Oolite facies. Neither is it impossible that a relation may exist between it and *A. Leai*, Forbes.†

So far as our present knowledge of Queensland Ammonites exists, there is no connection between the latter and either of the species described above, although our one bears some resemblance to Moore's *Ammonites macrocephalus*‡ from Western Australia.

The article then proceeded to refer to the fossils already described as collected by Mr. E. Edelfelt and Mr. T. Bevan, and this portion need not be repeated.

Such is a brief outline of the Palæontology of New Guinea, so far as it is known to the Writer. Briefly reviewing these facts, it is manifest that the oldest fossiliferous rocks on this Island-continent of which we at present have any record, probably correspond homotaxially with the Upper Oolites of other countries, more particularly the European, at the same time displaying some relation to the Indian beds of the same age. As regards the *Inoceramus*, it would appear to resemble an old-world Cretaceous species; but the specimen being a single one, too much stress must not be laid upon this point. It may simply be said that Cretaceous rocks put in a claim for consideration.

Of the Tertiary fossils it is necessary to speak more fully, but with caution. The presence of *Voluta macroptera* and *V. anticingulata* in the Yule Island deposit, would go a long way towards correlating the latter with the beds containing these shells at Schnapper Point and Muddy Creek, in Victoria, as suggested by Mr. C. S. Wilkinson. I was indebted to the kindness of the late Prof. W. T. Stephens, M.A., for an opportunity of examining the Yule Island collection in the Macleay Museum,§ but the species mentioned were not observed there, and only those described by the Rev. Mr. Woods came under observation. An attentive examination of these rather leads me to accept Mr. Woods' suggestions as to the age of the fossils in question. The matrix is also clearly the same as that containing the corals collected by Mr. Edelfelt at Maiva Village.||

The Urchin described as *Temnechinus* does not appear to belong to that genus as defined by its originator, Edward Forbes,¶ and at the present moment I am not prepared to generically place the specimen. It may probably be an undescribed form.

The *Peronella* would appear to be a small individual of the characteristic and generally distributed Australian species to which Mr. Woods has referred it. The

\* Pal. Franç. Ter. Jur. Ceph., i., Atlas, t. 177.

† Quart. Journ. Geol. Soc., i., p. 178, t. 12a and b.

‡ Quart. Journ. Geol. Soc., xxvi., t. 15, f. 5

§ The fossils were collected by Mr. J. Brazier.

|| Specimens are in the Mining and Geological Museum, as well as in the Queensland Survey Collection.

¶ Mon. Echinodermata Brit. Tertiaries, 1852, p. 5. The New Guinea fossil does not possess the typical excavations along the sutural margins of the plates seen in all true forms of *Temnechinus*, nor are the ambulacral plates confluent. These characters are emphasised by Forbes and accepted by A. Agassiz in his "Revision."

specimen of *Dolium costatum*, although only an internal cast, is one of so strongly and distinctly marked a species as to be readily recognisable from the other Australasian forms; the simple and distinct costæ and canaliculate suture distinguish it at once. The *Pecten novæ-guinæ* is not identical, says Mr. Brazier, with any existing species in neighbouring waters, and must therefore be regarded, with the so-called *Tenucechius*, as peculiar to the Yule Island deposit. It is, however, remarkably like a South American *Pecten*, described by D'Orbigny, from the Tertiary rocks of Patagonia, as *P. paranensis*.\* In addition to these species just mentioned, I detected in one of the blocks of the Macleay collection the internal cast of a *Strombus*, which Mr. Brazier regards as that of *S. (Gallinula) Campbelli*, Gray, a species now living in the Australian seas.

## E.

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\* See Darwin's Geol. Obs. Volc. Islands and Pts. of S. America; Voy. "Beagle," 2nd Edit., 1876, t. 3, f. 30. In *P. paranensis*, each costa, as in the New Guinea species, is divided into three or four ribs. The concentric laminae in the latter are continuous over the costæ and intervening valleys, forming frills, but in the former the ribs of the costæ are separately decorated by concentric lines of projecting tooth-like spines. The interior ear also in the South American form is more deeply divided than in our species, and the posterior is less granulate.

## CHAPTER XL.

### PETROGRAPHICAL NOTES ON SPECIMENS FROM QUEENSLAND AND ADJACENT COLONIES.

BY A. W. CLARKE, F.G.S.

#### INTRODUCTORY.

When the following Notes were being compiled I hoped that they would form portion of a larger work, viz.:—The description, in petrological language, of the rocks of Australia; but want of time, together with the difficulty of getting typical rocks from the other colonies, has narrowed the scope of this ambitious attempt, so that little has really been done besides describing a few of the rocks of Queensland and the neighbouring Colonies.

As a Queenslander (by adoption), I am glad to be able to contribute, in any way, to the codification of our natural history; and the appearance of these Notes in Messrs. Jack and Etheridge's Work on the Geology and Palæontology of Queensland is gratifying to me, and not inappropriate, since nearly every rock described in the following pages was collected by the Government Geologist, or by members of his Staff. For the last three years I have constantly been supplied with field notes and reports on these rocks, and am now entrusted with a great deal of the petrological work of the Geological Survey, so far as the preparation of rock-sections is concerned.

The microscopical drawings, signed "J. Phœbe Clarke," were drawn and painted from the microscope by my wife. To those persons who know anything of the subject, they tell their own tale; but for general readers it may here be necessary to describe, as shortly as possible, what they mean and teach.

*Imprimis*, the drawings are made from the highly magnified images of extremely thin films of rock. Each film is preserved between two glasses, which are made to adhere together by means of Canada balsam. These films or sections show the exact relative positions of the different constituents of the rock. When they are placed under the microscope, and light is reflected from the sub-stage mirror through the section, the structure or texture of the rock is revealed, and this is a highly important factor in the grouping and classification of rocks. Thus the New Guinea rhyolite, No. 108, drawn on Plate 61, fig. 1, represents fluxion-structure, as do several other of the drawings appended to these Notes.

In petrological language, "fluxion-structure" means that the section bears irrefutable internal evidence of flow during that period of the existence of the rock when its temperature just allowed the creation out of the molten magma of one or two classes of minutely crystalline minerals, which thus become indices of the past movement of the rock.

In examining this particular group of rocks it is easily seen that the microscope plays an important part; for to the naked eye the little lath-shaped crystals seen in the magnified section are generally invisible, while the microscope discovers their presence and arrangement in vast numbers throughout the glassy base, resembling what occurs when a bundle of twigs and straws is cast into a running brook—viz., the twigs and straws arrange themselves end to end in the direction of the flow of the brook. Rocks whose sections reveal, microscopically, this end-to-end arrangement of lath-shaped crystals (crystallites) are placed in the rhyolite group.

There are other rock structures or textures which are described in various textbooks on the subject, and occasionally our own Australasian learned Societies deal with

the subject in their published "Proceedings." But the fluxion-structure is the most striking, and it suffices to illustrate, in this particular direction, the value of the microscopical examination of rocks.

The microscopical examination of its section does more, however, than merely disclose the structure of the rock, for, by using polarized light instead of ordinary light and an analysing Nicol's prism (usually referred to as a "Nicol"), the observer goes further, and is able to identify the different component minerals constituting the rock.

It is hardly possible to explain, in a short introductory chapter, how this is done; but, to simplify the matter so that general readers may be attracted to, and not repelled from, what is really a most attractive subject, I will try to explain how polarized light differs from ordinary light.

If we imagine a ray of ordinary light to be magnified many millions of times, then that portion of a test-tube cleaner which carries bristles, or the same portion of the cleaner supplied with an infant's feeding bottle, may represent, roughly, the ray of ordinary light, the wire being the path, and the bristles representing the *cross* vibrations of the ether-particles. By arranging the bristles parallel to each other a fair illustration is obtained of the polarized ray.

Thus, then, in *ordinary* light, the ether-particles vibrate in *all* directions *across* the path of the ray; and in *polarized* light, the ether particles vibrate in *parallel* planes *across* the path of the ray.

Now, to produce polarized light we can compel the ether-particles to vibrate in parallel planes, in two ways—either by *reflection* from glass or polished metallic surfaces, at certain angles, dependent on the nature of the reflecting material; or by refraction through crystal plates. Nicol (a Scotch professor) found out how to obtain this polarized light by compelling it to pass through prisms of Iceland spar (a variety of calcite), specially cut and prepared; and this is the method universally adopted in petrography at present.

To recognise when light is polarized requires a similar prism or reflecting plane. Either does, no matter what means are employed for polarizing the light to be examined.

In the microscopes used for petrographical work there is a polarizing prism beneath the stage, and a precisely similar prism over the eye piece. Both can be revolved; and by adjusting the analysing prism so that its principal axis is at right angles to that of the lower polarizing prism, perfect darkness covers the field of the microscope, and the nicols are technically known as "crossed."

By turning the analysing prism the field gradually gets illuminated till at 90° the maximum of illumination is reached, and the nicols are said to be "parallel." A continued revolving of the analysing prism would lead to the gradual darkening of the stage until no light passed through, when the nicols would be again "crossed."

Most of the drawings illustrating these Notes represent sections as viewed between crossed nicols, and under such circumstances the different minerals exhibit characteristic optical properties. For instance, the bands appearing in one of the minerals in the drawing of the Cape Upstart section certainly prove it to be one of the felspar group of minerals. Again, colour is of some value, certain minerals being illuminated vividly, like the augite crystal depicted on Plate 65, fig. 2; while orthoclase is always a delicate lavender grey. These colours vary, however, being dependent on the thickness of the section.

There is one system of crystals belonging to the cubic form and its derivatives, none of which are illuminated at all, even in thick sections.\* To this group belong fluorspar, garnets, &c. They are, therefore, easily recognised.

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\* A thin section may be about .001 inch or less, while a thick section would be about .006 inch or even thicker.



Finally, to render this introductory preface as complete as possible, I will briefly describe the method of preparing rock-sections.

Sorby \* (one of the fathers of petrography) prepared his sections by grinding a flake of the rock and polishing it on one side.† The polished surface is next cemented with Canada balsam to a piece of plate glass, which latter forms a sort of handle, as well as insuring more or less parallelism between the two faces of the polished film. The best grinding surface is plate glass with a sprinkling of emery powder (No. 40); and for polishing, I always use flour emery, on another and similar glass plate. The powders are kept fairly moist with water. The rough side of the mounted flake is then ground down till a mere film of rock remains adhering to the glass. That film is the "section." When properly ground it is in most cases perfectly transparent—hornblende transmitting green light; quartz, white light; and felspars being more or less transparent, according to the changes that the rock may have undergone.

Different students have, of course, different methods of working. I use a lapidary's wheel, which facilitates the work; but the simplicity of the other apparatus commends itself to a frugal mind.

Having then obtained a film of rock containing various contiguous minerals, the thickness of which may vary between '006 inch to '001 inch, we proceed to mount it in Canada balsam, and then to examine it according to the methods detailed in the above sketch. In this way, a rock-section, when carefully prepared and examined, reveals to a trained eye different contiguous mineral films. The structure and texture of the aggregate is first noted; next the minerals are examined for their optical properties, which are compared with the tabulated optical constants of rock-forming minerals, and thus identified.

Lastly, under a high power,  $\frac{1}{4}$ -inch or  $\frac{1}{8}$ -inch objective, the gases, liquids, and solids included in the different minerals are observed. Under such a power quartz reveals vast masses of gas-bubbles and liquids with little oscillating bubbles. These bubbles go on travelling round the walls of their tiny prisons apparently for ever; and in one section, '001 inch thick, literally scores of these enclosures can be seen between the two polished surfaces of the section. In one of Fuess's sections under '001 inch thick, belonging to Mr. Jack, I have counted over ten almost superimposed, yet never touching each other, and with room for a score or so more, in each of which the little bubble flew round.‡ In this particular section there were over 1,000 enclosures in every cube whose edge measured '001 inch, and this was by no means a quartz rich in enclosures. Quartz is not the only mineral exhibiting such phenomena.

In concluding these few Notes, introductory to the science of petrology and petrography, I will leave the general reader to form what judgment he can on the microscopic structure of some of our Queensland rocks, asking pardon from students of geological science for my temerity in writing such a bald introduction to so vast a subject.

A. W. CLARKE.

Charters Towers, 26th June, 1892.

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\* H. C. Sorby, F.R.S., late Pres. Geol. Society.

† Mr. W. H. Rands, F.G.S., Assistant Government Geologist, obtains excellent flakes by smashing, with a vigorous blow from a sledge hammer, a large lump of the rock; amongst the debris, Mr. Rands states that generally several suitable flakes will be found.

‡ Mr. Jack informs me that these sections have been in his possession for more than sixteen years; and yet they *still* show the oscillation.

## NOTES.

## GRANITES.

## No. 26. KING OF CROYDON CLAIM, CROYDON (QUEENSLAND).

R. L. Jack's Collection. Sp. Gr. 2.661.

Colour red. Granular, allotriomorphic. Water-clear quartz, reddish feldspars, hornblende sparse, with magnetite, epidote, and ferrite as secondary minerals.

Quartz clear, allotriomorphic, with numerous inclusions; some rather large with moving and fixed bubbles, the latter unaltered by exposure to ice, or a jet of hot air blown on to the section through a blowpipe whose tube was heated with a small spirit-lamp while the slide was on the microscope stage. A few long clear fine prismatic needles penetrate the quartz in no particular direction, in some cases passing through the quartz into a neighbouring feldspar. Their index of refraction must be high, for the needles shine out sharply with dark borders. I think they are rutile, which Teall suggests as occurring in the quartz of some of the Scotch granites; only he describes them in a single word as being "hair-like,"\* while these needles are not trichitic. An actual measurement (with a Stage Micrometer, however) gave  $\cdot 03 \times \cdot 0005$  inch. Ferrite is enclosed in the quartz, amorphous, visible under the  $\frac{1}{4}$ -inch objective. With the ferrite occur flecks and specks of what must be hæmatite, being bright orange-red and transparent to translucent, but they are found more in the irregular cleavage-cracks and fissures, pointing to secretion, from pre-existent minerals, carried on for ages by the infiltration of water.

Feldspars much altered, nearly opaque. They enclose dirty light-green epidote. Magnetite occurs once only, associated with possible epidote and chlorite, in the wreck of a plagioclase feldspar. In ordinary transmitted light there appear long parallel cuts, allowing the light to pass up through a semi-opaque mass of dusty and cloudy matter. Between crossed nicols, these lines are parallel with an axis of extinction. Whether this is due to the "aggregation of a perfectly uniform colourless substance along the cleavage-cracks of an orthoclase crystal," as noted by Rosenbusch,\* I cannot say. The structure is common in the feldspars of Croydon and Charters Towers, and among other granites.

Hornblende brown, showing cleavage parallel to *C*, generally fringed with epidote. If the hornblende abuts on quartz and feldspar the epidote prefers, invariably, to secrete itself on the feldspar side. A few instances of the fan-shaped groups of epidote occur, as drawn in Zirkel's Petrography.†

## No. 162. ETHERIDGE GOLD FIELD (QUEENSLAND).

R. L. Jack's Collection. Sp. Gr. 2.615.

Colour greyish white. Granular, with large fresh idiomorphic feldspars, often  $\frac{1}{8}$ -inch long, with well-marked cleavage.

Quartz allotriomorphic, and the whole speckled with small grains of biotite. Very little hornblende. Both biotite and hornblende are accessory minerals.

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\* J. J. Harris Teall. *British Petrography*, 1888, p. 324.

† H. Rosenbusch. *Microscopical Physiography of the Rock-making Minerals*, translated by Joseph P. Iddings, 1888, p. 286.

‡ Ferdinand Zirkel. *Microscopical Petrography*, in *Report Geol. Explor. Fortieth Parallel Washington*, 1876, Plate iii., Fig. 4.

Felspars frequent and fairly fresh, consisting of orthoclase, microcline, and plagioclase. The first is the least fresh, and often there is an intergrowth of the first two mentioned. The microcline is exquisitely lined, markings under the  $\frac{1}{4}$ -inch being finer than the finest lines in a good steel engraving. The simultaneous extinction of the two sets of cross lines is marked; one set of cross lines is less perfect than the other, being slightly spindle-shaped or wedged. The angle between the two sets of lines varied between  $91^{\circ} 30'$  and  $93^{\circ}$ , but it is not easy to see when the cross web exactly coincides with the less regular cross lines of the felspar, so that the angle in no case is quite accurately measured. In the plagioclases the angle between the traces of the twinning planes and an axis of elasticity is between  $7^{\circ}$  and  $10^{\circ}$ . In one case the angles of extinction on either side of the twinning planes were  $8^{\circ} 10'$  and  $7^{\circ} 30'$ —angles so nearly equal that it will be safe to assume that the section of the crystal is cut parallel to the zone at right angles to *M*. The nearest angle to the mean of these given in Rosenbusch\* is  $7^{\circ} 35'$ , which would give a formula to these felspars of  $Ab^3$  and  $An^4$ .†

Quartz rich in inclusions and microlites. The inclusions are sometimes fluid and dihexahedral, with moving bubbles. The microlites are an interesting feature in the rock, as they closely resemble those in the quartzes of granite found at Summit Springs, Ilovalah Range, North America, described and drawn by Zirkel; but he describes them as being black, whereas the microlites in the quartzes of my section are milk-white by reflected light, strongly resembling the raphides found in *Typha angustifolia*, Linn.,‡ except that the microlites much exceed the raphides in length.

The quartzes do not always polarize uniformly, and may be described, according to Professor Hutton's nomenclature of rock textures, as granulitic.§

The Mica is a dark-brown biotite, and very sparsely distributed.

#### No. 14. COOKTOWN (QUEENSLAND).

F. Bauer's Collection. Sp. Gr. 2.6437.||

Colour grey. Granular, allotriomorphic. Felspars large, commonly  $\frac{1}{4}$ -inch and sometimes  $\frac{1}{2}$ -inch long, idiomorphic, cleavage well-marked when held in light falling on it obliquely. Sparsely scattered allotriomorphic quartz. Little hornblende. Biotite and tourmaline in minute black shining grains and prisms.

Quartz rich in inclusions, varying considerably in size, a few just visible under the 1-inch objective; some fluid, with moving bubbles; others with fixed gas pores, also glass inclusions. They are all spread out in planes traversing the crystal and crossing each other at low angles. The more persistent are rudely parallel to an axis of elasticity, possibly the principal axis. The micrometer screw shows how they "hade" in all directions. What I take to be the glass-inclusions are very irregular in outline, being pear-shaped, globular, and quite irregular, resembling the smear left by an oily finger on perfectly polished glass or the magnified image of a finger-mark on a glass-slip such as is used for mounting microscopic objects.

Felspars much decomposed, showing the clear, straight lines described in the Croydon granite, No. 26 (probably orthoclase).

\* "Microscopical Physiography," p. 300.

† Where *Ab* represents albite, and *An* anorthite. *Vide* note at end of Chapter.

‡ A burrush infesting tailings-dams at Charters Towers. *See* "Synopsis of the Queensland Flora," by F. M. Bailey, p. 571. Brisbane: by Authority: 1883.

§ Prof. Hutton's Catalogue of Rock Textures, as given in his Paper, on "The Eruptive Rocks of New Zealand." (Proc. R. Soc. N.S. Wales, 1890, xxiii., p. 107.)

|| In determining these Sp. Grs., as large a piece of rock as could be procured has always formed the material for experiments. The piece used in this determination weighed 18,189 grains, which warrants carrying the calculation to the 4th decimal place. This rule has been observed throughout.

Tourmaline is in short stunted prisms, very pleochroic, varying from red, pink, yellow, and green to blue. Often the tourmaline is in rounded grains.

Biotite in hexagonal brown plates, very small. No magnetite, and very little apatite.

#### COOKTOWN (QUEENSLAND).

A. J. Madden, Esq., Collector.

Tourmaline and cassiterite associated with quartz.

Although this aggregate of minerals has no place amongst the granites, it comes in with some advantage here, because Plate 63, fig. 2, illustrates a tourmaline crystal in quartz from the same Cooktown district. The tourmalines drawn on the plate show the pleochroism and the cleavage of the microscopic tourmalines in the Cook district. The section was prepared from a piece of quartz-carrying cassiterite and tourmaline, forming part of a large sample of tin ore sent for assay by A. J. Madden, Esq., of Cooktown. The exact locality is not known to me. The ore is typical of over a hundred samples assayed by myself from time to time from the neighbourhood. The tourmalines tend to separate into segments transverse to the principal axis (*i.e.*, along the cleavage), quartz filling up the spaces left. The quartz so introduced between the segments "orients" uniformly with that contiguous to the sides of tourmalines. The quartz does not always uniformly polarize, however; much of it is in the form of granulitic aggregates. These aggregates often, but not always, border large grains of quartz, separating it from its neighbours. In these quartzes the tourmalines pass through larger grains and aggregates, sometimes being separated into segments in the larger crystals, and at others in the suture.

The interesting question arises, which of the two minerals is the first born. Rosenbusch says\* that "tourmaline is not directly secreted out of the eruptive magma in eruptive rocks, but resulted from the action of fumaroles, carrying fluorine and boron, on the eruptive rock, especially on its felspar and mica." Teall also alludes to the action of fumaroles in the genesis of tourmaline. This would rather support the pre-existence of the quartz. On the other hand, the uniform orientation of the quartz between and alongside of the broken prisms would lead one to think that the reverse was the case. Could it be that the tourmaline crystallised out in the quartz by the action of fumaroles, as above, while the quartz was viscous and under pressure, and that earth-stresses and dynamic metamorphism followed, separating the prisms, after which the quartz proceeded to crystallise?†

Cassiterite is in brown, gum-like drops, sometimes honey-yellow, included between tourmaline prisms.

Quartz very dusty and, under the  $\frac{1}{4}$ -inch objective, shows yellow, yellowish-red, and red flecks, probably hydrated oxides of iron. The inclusions are very numerous, but exceedingly minute. Some are liquid; others might be liquid with gaseous envelopes, but this has not been definitely ascertained. Certainly some of the inclusions contain oscillating bubbles only visible under the  $\frac{1}{4}$ -inch. In all of the section prepared of this rock or sample of tin-bearing quartz, the tourmalines were sharp and highly

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\* "Microscopical Physiography," p. 184.

† Since these slices were prepared Mr. Jack has shown me a most striking example of the parting of tourmaline in quartz, the quartz having filled up the spaces between the segments just as in the above samples, but the evidence of dynamic metamorphism is much more striking in this sample (which comes from the same district, and, I strongly suspect, from the same mine). Mr. Jack's specimen shows how the tourmaline has also been bent out of the straight, small bundles of the prisms following the curve. The bundle of tourmaline crystals forms a flagellum about four inches in length. The specimen came from the Mount Leaswell Tin Mine, Cooktown.

crystalline. The edges of the partings are still jagged, when highly magnified ( $\frac{1}{4}$ -inch objective), as they were the day they separated. On the other hand, the tourmaline in the Cooktown granite is highly granular, and the small prisms by no means sharp.

No. 250. MOUNT BISMARCK, COOLGARRA (QUEENSLAND).

A. G. Maitland's Collection. Sp. Gr. 2.66.

Colour, dark-brown. Fine-grained, almost microgranitic. Quartz, hornblende, with epidote in grains, plagioclase and orthoclase.

*Section*.—Quartz is hardly granulitic, owing to the epidote, which is interstitial. But for this it would fulfil the definition—viz., "In approximated allotriomorphic grains, small, of nearly the same size, and independently oriented."

Rare mica; in one case it is fibrous, much broken up into *septæ* between crossed nicols, the ends of the fibres frayed out, the whole slightly curved in the form of the letter S.

No apatite or magnetite.

No. 257. DERWENT CREEK, COOLGARRA (QUEENSLAND).

A. G. Maitland's Collection. Sp. Gr. 2.718.

Colour, dirty red. These rocks are not true granites, and, according to Professor Hutton's system, would be placed in the elvanite group, as they consist of microgranitic orthoclase and quartz, with porphyritic crystals of quartz and orthoclase, and sparsely distributed hornblende, or perhaps mica.

*Section*.—The quartzes are generally allotriomorphic, and often the felspar and quartz are in a crystalline-granular state—pegmatitic (graphic-granite). Rutley would probably class these two rocks as haphazites. The pegmatitic quartzes carry the usual inclusions, but they are minute, and a great many are mobile. The inclusions are not arranged in lines, but occur without system, and, as it were, haphazard; while in the porphyritic quartzes the inclusions are arranged much more systematically, being generally strung together in lines, which, however, bear no constant relation in their direction to the crystallographic or any other axis.

The felspars are finely fibrous. One single example occurs of plagioclase. It is too much altered to classify, but it is distinctly banded; and the angles of extinction, right and left of the twinning planes, are—right,  $10^{\circ} 40'$ ; left,  $15^{\circ} 30'$ .

The fibres cross at an angle of  $46^{\circ} 30'$ . Some of these fibre-spectra cross each other at right angles, and are suggestive of microcline, but the felspars are all so opaque that their optical properties are not discernible with any precision. Unfortunately, in the three slices beside me of this rock, the hornblende or mica is absent. One or the other, however, occurs, or perhaps both may occur, as accessory minerals visible to the naked eye, in the hand specimens.

No. 255. DERWENT CREEK, COOLGARRA (QUEENSLAND).

A. G. Maitland's Collection. Sp. Gr. 2.568.

Colour, a dirty grey, with ill-defined dirty green specks of secondary origin. The same remarks apply to this rock as to No. 257, except that some ferrite occurs, and a little epidote around very minute hornblendes.

## No. 188. HOMESTEAD RANGE, NORTHERN RAILWAY (QUEENSLAND).

W. H. Rands' Collection. Sp. Gr. 2.58.

Colour, red. Would be placed by Professor Hutton in the same class as Nos. 255 and 257.

Orthoclase is the prevailing feldspar. Sometimes the latter is quite clear and limpid. The kaolinized feldspars are stained red with oxide of iron, and sometimes ferrite is concentrated round centres, the eyes of which are opaque, the edges being transparent and just stained.

*Section.*—Micropegmatite occurs, showing the simultaneous extinction of the interpenetrating quartz when the section is revolved. The quartzes contain the usual fixed and oscillating bubbles. The micrometer-screw reveals planes formed of extremely minute inclusions which have a faintly pink tinge to my eye, and are transparent. The inclusions are probably glassy. Sometimes their shape is similar to that of the inclusions described as occurring in quartzes in the Cooktown granite, but more often they are round or ovate; the smallest would measure less than .0001 inch. The micrometer-screw shows how they traverse the crystal in various planes, whose directions are independent of any of the crystal axes. The quartz, when porphyritic, is often idiomorphic, as is also the orthoclase. Macroscopically, the rock carries sparse black specks, which have not been determined.

## No. 202. NORTH OF CHINAMAN'S GULLY, CAPE RIVER GOLD FIELD (QUEENSLAND).

W. H. Rands' Collection. Sp. Gr. 2.663.

Colour, nearly white. Quartz, white mica, feldspars, and garnets, the latter pale yellow. The structure is granular, granitic, or holocrystalline, and the minerals are all fresh and transparent.

*Section.*—The feldspars are most abundant, and therefore come first. One feldspar is much kaolinized, but still sufficiently fresh to identify.

The axes of extinction, on either side of well marked cleavages, are—right,  $7^{\circ} 20'$ ; left,  $8^{\circ} 50'$ . The cleavage being so well marked, and the angles of extinction with regard to it being also well marked, show that the section is probably cut parallel to the plane of symmetry 010, and the cleavages must be parallel to the basal pinakoid, all pointing to orthoclase which is rather fresh. In addition, there are plagioclase feldspars, some very finely striped and others coarsely striped, suggestive of oligoclase.

The mica is a potash mica, and possibly muscovite. The sections show marked absorption for rays vibrating parallel to the basal planes in such crystals as are cut transverse to the lamellæ.

The garnets appear brilliant and rough, of course, by reflected light, owing to their high index of refraction. Their optical properties are normal, and irregular cracks traverse the crystal. The grains average .01 inch in diameter, and are of a pale-yellow pink colour. Probably they are almandine garnets. The inclusions in the quartzes are very small, being only just discernible under the  $\frac{1}{4}$ -inch objective, and under the  $\frac{1}{4}$ -inch a few minute moving bubbles were to be seen.

## Nos. 240, 241, 242, 243. VICTORIA REEF, CHARTERS TOWERS (QUEENSLAND).

These rocks were collected by the Hon. H. Mosman, M.L.C., with the view of determining, through Professor Judd, whether there is any difference between granite bordering gold-bearing reefs and granite bordering non gold-bearing reefs. The four samples were sectioned in my laboratory; and before their despatch to Professor Judd,

I examined them. Nos. 240 and 241 are from the hanging and foot walls respectively of gold-reef-bearing granite; while 242 and 243 are the hanging and foot walls of the non-gold-reef-bearing granite.

Macroscopically, the specimens are grey. No. 240 is permeated by one single vein,  $\frac{1}{16}$  inch thick, of a zeolite, which I have often analysed, as per Mineral Census, Royal Society, Queensland, &c. *Vide* Plate 67, fig. 2. The rock consists of quartz, feldspars, and hornblende. There is no mica visible with a lens in the hand specimens.

*Section.*—The texture is granitic, holocrystalline. The richness of the quartzes in fluid-inclusions is very great. Planes of these inclusions intersect in various directions, and each plane absolutely teems with fluid-inclusions. Under the one-inch objective, by oblique reflected light, these inclusions appear beautifully silvery. The hornblende is bright green, in part often crumpled, and sometimes reedy (the “schilfige hornblende” of Rosenbusch).

Well-defined crystals of magnetite appear, both included in this hornblende and on the margins. The magnetite occurs in the feldspars when remote from hornblende, and in one case the octahedral crystal is in quartz, having been derived from the hornblende which is contiguous to the quartz, but this is uncommon. All these exhibit strong magnetism on powdering and washing off the dirt, and using the magnetised needle as a means of separation. In the neighbourhood of magnetite crystals, exquisitely clean-cut apatite crystals aggregate, as is the habit of this mineral. In a prism of apatite, .008 inch long and .001 inch broad, there is a fluid-enclosure whose figure is symmetrical with its host.

The hornblende is frequently interpenetrated by epidote of a yellowish-green tint, polarizing in high colours, and appearing, by reflected light, very rough on the surface, owing to its strong index of refraction. The pleochroism of the hornblende is, for rays vibrating parallel to cleavage, bluish green, and at right angles it is yellow. In many crystals the cleavages are parallel to an axis of elasticity.

*Feldspars.*—They are much altered, probably orthoclase amongst them, but not certain, and in small quantity. The section must be fairly thin, since the quartzes only colour to No. 13 in Newton’s scale, and sometimes lavender grey, yet the great majority of the feldspars are filled with a perfectly transparent colourless mineral, which is strongly coloured between crossed nicols. From the fan-shaped groups of some of these invested secondary secretions, it is probable that they are epidote. Some may be calcite. In No. 241 orthoclase occurs sparingly and between crossed nicols; the feldspar is not simultaneously extinguished on turning the stage. A black envelope environs a luminous centre, and that is succeeded by a luminous envelope environing a black centre (*i.e.*, “undulose extinction”).

There is a curious affinity between the magnetic iron and the apatite. Very little difference exists between the hanging-wall of the gold-bearing quartz and the hanging-wall of the non-gold-bearing quartz. In No. 242 there appears perhaps less hornblende than in No. 240, and what there is, is more crumpled. In No. 243, the feldspars are less kaolinized, and orthoclase twinned on the Carlsbad type occurs together with plagioclase. One large orthoclase crystal shows signs of zonal structure, and exhibits undulose extinction.

In No. 242 the feldspars are most delicately banded, and the hornblende is crippled, while the other parts of the slide can be described as in the foregoing cases. Some of the feldspars in No. 240 appear like picture frames with much beading, slightly thrust on one side—*i.e.*, like quadrilateral figures with their opposite sides equal, but all their angles not right angles.

## WELLINGTON REEF, CHARTERS TOWERS (QUEENSLAND).

From 600 feet vertical depth. Portion of core from diamond drill.

*Section.*—Quartz shows fewer and smaller inclusions, sometimes very minute and red (hæmatite probably). Epidote and magnetite as before. A little apatite, but less than in the four previous rock samples; orthoclase and microcline, the former being often filled with fine particles of mineral matter polarizing in high colour. *Vide* Rosenbusch on "Epidote." \*

The other felspars are much decomposed and difficult to identify. The orientation in most of the felspars is undulose. This was the first of a series of rocks that I sliced in Charters Towers, and is hardly thin enough for microscopic examination, the quartzes all polarize in a deep purple colour, owing to this, whereas in the previously described samples from Charters Towers, the quartzes are all light yellow or lavender.

The hornblende is much replaced by minerals of secondary origin, viz.—epidote, chlorite, magnetite, and viridite.

## NORTH AUSTRALIAN REEF, CHARTERS TOWERS (QUEENSLAND).

From deep ground.

The special characteristic of this rock is the very large amount of hornblende present. Unfortunately I have only the slice, which is too thick, as it belongs to a group of rocks similar to the preceding.

There are two varieties of hornblende, a grass-green species with feeble absorption for rays vibrating parallel to an axis of elasticity. Then there are some granules with very irregular outlines, whose greatest length and breadth would not exceed .01 inch, whose pleochroism is very marked, ranging through green, yellow, and rose-pink to red, in the course of a quarter revolution of the stage. At one position of the stage the centres will be surrounded by zones of different colours. These, from the high refractive index, should be epidote. The other species of hornblende is brown, showing well-marked cleavages, with an angle of extinction of  $14^{\circ} 40'$  to these cleavages. In other examples of the hornblende the extinctions with regard to cleavage, fall to  $0^{\circ}$ . Absorption very strong for rays vibrating parallel to cleavages. The felspars show a high angle of extinction ( $-29^{\circ} 40'$  on P.) Therefore there must be much anorthite present, as indeed is shown in the following partial analysis of a Charters Towers granite published in the Annual Report of the Mines Department for the year 1887.† The sample is from the Court-house Reserve, and was dressed up from a boulder at surface. The sample looked quite clean, and was not perceptibly weathered.

Silica	...	...	...	...	...	72.00	per cent.
Iron	...	...	...	...	...	...	...
Alumina	...	...	...	...	...	...	...
Lime, CaO	...	...	...	...	...	3.22	„
Loss on ignition	...	...	...	...	...	0.50	„

The iron and alumina together present in the sample weighed over 20 per cent. No attempt was made to ascertain whether the iron was protoxide or ferric oxide.

The felspars are twinned on the albite and pericline law, and often highly kaolinized. Orthoclase rare.

The quartzes are full of inclosures, and the same description given in Nos. 240 to 243 applies here.

\* "Microscopical Physiography," p. 286.

† Brisbane: by Authority: 1888.



Microoliths, probably of hornblende, occur, and apatite often penetrates the hornblende, and is easily recognised by its glaring limpidity, and when cut transversely on *o P* the crystal sections are, of course, hexagonal and isotropic.

Magnetite occurs as in other Charters Towers rocks.

#### COURT HOUSE RESERVE, CHARTERS TOWERS (QUEENSLAND).

Surface boulder, weighing several tons

Is very similar to the last, except that, being a surface stone, has suffered from weathering, the result of which is that there are few minerals fresh enough to be of much interest, except the quartz, which is exceedingly rich in fluid and gaseous inclusions. Magnetite abounds.

The triclinic feldspars show marked cleavage, rectangular to the striations; and the orthoclases show striæ. The minerals of secondary origin are similar to the other Charters Towers samples of granite.

#### UNITED QUEEN CONSOLS REEF, CHARTERS TOWERS (QUEENSLAND).

"Deep ground."

Differs from the North Australian sample in the sparseness of hornblende and its derivatives.

The constituents are granular quartz and feldspars, with an occasional prism of actinolite. The rock sometimes has blade-like crystals of green actinolite, two or three inches long. The feldspars are like those occurring in the Cooktown granite, No. 14 showing the white ruled surface by reflected light, the ruled lines being transparent by transmitted light, and being extinguished parallel to the principal section of the polarizer between crossed nicols.

A little chlorite showing feeble absorption. No epidote. Magnetite, or apatite, and the feldspars and quartzes, as a rule equal in size, measuring .01 inch.

#### NO. 6. STAR RIVER (QUEENSLAND).

R. L. Jack's Collection. Sp. Gr. 2.69.

Colour, dark-grey. A medium-grained rock with quartz, feldspar, and black mica (biotite) in fairly equal proportion, and a little hornblende.

*Section.*—By reflected light, pure milk-white feldspars, other limpid feldspars, clear quartz, and dark mica, some black-lustered mineral enclosed in mica and a very little light greenish brilliant epidote.

*Feldspars.*—Some of the triclinic feldspars are exquisitely marked, the crystals being fresh and the bands extremely fine and sharp. The finest in the slice is .08 inch long by about .027 inch broad.\* There are twenty-two parallel lines, whose extinction right and left of the normal to the twinning plane *M* is  $6^\circ$  and  $6^\circ 10'$ , respectively, so the section must be about exactly normal to the twinning plane. Another feldspar gave  $22^\circ 10'$  and  $22^\circ 30'$  on either side of the boundary lines between the lamellæ. Some of these feldspars are not uniform in their orientation, and some of the orthoclases show zonal structure. The inclusions in the plagioclases are numerous; some consisting of clear, colourless, rounded grains; and others similar, but green. With these are black opaque grains, probably magnetic iron, also trichites. The orthoclases are very dusty, with possible kaolin. The hornblende fringed with epidote in places, sometimes highly

\* None of my microscopic measurements are exact, as they have been determined with a stage micrometer.

pleochroic, showing bright green, red, and yellow. Some of the hornblendes are pierced with apatite, its hexagonal section looking like holes. Some of the hornblende has a highly pleochroic tip or feather-edge, which for light vibrating parallel to the cleavage, is reddish-yellow, and at right angles, blue. Many microliths of hornblende in the quartz.

The quartz is not plentiful, but is allotriomorphic, full of small inclusions and microliths, much traversed by planes of inclusions, a few with very dark margins pointing to gaseous, a few mobile pointing to fluid, and a few sporadic, probably glass, and a vast quantity of dusty particles.

The mica is probably biotite, often pierced by apatite.

Magnetic generally contiguous to the hornblende, and in the neighbourhood of apatite. The apatites are larger than usual, measuring about  $\cdot 001 \times \cdot 002$  inch.

**No. 77. KIPPER POINT, MOUNT ELLIOTT, NEAR TOWNSVILLE (QUEENSLAND).**

R. L. Jack's Collection. Sp. Gr. 2·628.

Colour, reddish-brown.

Felspars, quartz, mica, and hornblende. Microscopically there appears to be more felspar than all the rest added together. Felspars orthoclase twins, Carlsbad type, rather altered, showing bright lines as described in the Cooktown and Etheridge granites, often interpolating felspars of the albite and oligoclase type with somewhat broad lamellæ.

The rock derives its reddish-brown tint from the oxide of iron which stains the orthoclase. Plagioclase, very fine, large, the crystals delicately cross-hatched, looking like the plan of a building, but not quite rectangular. In the centre of these rhombohedral figures are inclusions of ferrite, hæmatite, apatite, and dusty matter.

The apatite is plentiful and ranges in size from  $\cdot 005$  inch across the section of prism to  $\cdot 0005$  inch, and these latter are sometimes  $\cdot 04$  inch long. Amongst the colonies of apatites are generally to be found greenish hornblende and magnetite. Epidote is rare.

Quartz sparse, containing the usual inclusions, which, however, appear fixed, and, from the dark borders, may be glass. The quartz seems to be peppered with dusty particles and glassy inclusions.

**No. 76. MAGNETIC ISLAND, NEAR TOWNSVILLE (QUEENSLAND).**

R. L. Jack's Collection. Sp. Gr. 2·641.

This rock is similar in every respect to the preceding, except that it appears more weathered, and perhaps carries more hornblendes. It obviously belongs to the same series.

**No. 25. MOUNT CATHERINE, ST. HELENS, NEAR MACKAY (QUEENSLAND).**

A. G. Maitland's Collection. Sp. Gr. 2·64.

Colour, grey. Fine-grained, no mineral large enough to identify without a lens, microgranitic, holocrystalline.

*Section.*—By reflected light, lath-like milky felspars; green hornblende, the larger sections of which are pierced with pellucid apatites which shine like diamonds; biotite in grains; and but little quartz; the whole section literally peppered with magnetite.

*Felspars.*—About three-fourths of the section is made up of the lath-shaped felspars, which are opaque, even on the edges of the section which is always the thinnest part, being feather-edged. One much altered felspar shows the fine striæ in the centre, but it becomes lost on the margins, where the kaolinization has effaced it as a felspar. Another felspar  $\cdot 1$  inch long, is very clear, and for a portion of its length is nearly  $\cdot 015$  inch broad, and shows the traces of twinning plane *M* very clearly. Quartz, crossed by very pale, slender needles, probably hornblende, inclusions unimportant and sparse. Hornblende well marked when cut parallel to *o P*, showing cleavages crossing at the angle of about  $125^{\circ}$ . Magnetite abounds. The larger particles, however, are found more often in the neighbourhood of the hornblende, associated with apatite. Biotite showing marked absorption for the rays vibrating parallel to cleavage. When cut parallel to the base they are difficult to identify, owing to their granular state. A little pyrites in minute cubes in the powder when panned off.

No. 74. MACKAY (QUEENSLAND).

A. G. Maitland's Collection. Sp. Gr. 2.68.

Colour, dark greyish-brown. Highly felspathic, hornblende, and very little quartz.

*Section.*—The bulk of this rock is made up of triclinic felspars,  $\cdot 07$  to  $\cdot 1$  inch in length. Originally, these felspars must have been extremely beautiful—even now the striations are exquisitely regular when not marred by kaolinization.

In one mass of twins there are ninety-three lamellæ, broken here and there by opaque secondary minerals, but the stripes pass "through" the shadow, as it were, and emerge clean-cut and bright. The angles of extinction, with reference to the twinning planes are, right  $2^{\circ}$ , left  $9^{\circ} 40'$ , and in another, right  $2^{\circ} 50'$ , left  $8^{\circ} 30'$ . Again, in another, whose colours, in maximum illumination between crossed nicols, are, for one set of lamellæ, pale-yellow; for the other, white. The angles are, right,  $24^{\circ}$ , and left,  $5^{\circ}$ . Another gives right,  $1^{\circ} 10'$ , and left,  $7^{\circ}$ .

Orthoclase occurs in the usual Carlsbad twins, but not plentifully. All the felspars exhibit more or less undulose extinction.

The angles given above are taken from the central extinction as far as possible. In one or two cases the stripes have violet centres and blue ends, with the quartz plate and the analyser arranged for a violet field. Hornblende reedy ("schilfige") and absorption feeble, much epidotized. The crystals have been seriously mutilated in the process of grinding, the centres of nearly all being ground away, leaving microliths of hornblende in a ragged state, arranged marginally around cavities originally occupied by the mineral.

Magnetite and apatite, the former always and the latter occasionally, associated with the hornblende. The apatite, however, is small and infrequent. One or two hexagonal sections of apatite occur in the felspars.

Quartz in allotriomorphic grains, playing an insignificant part in the constitution of the whole rock, pretty much of one size,  $\cdot 01$  inch in diameter. The enclosures are normal but large, in some cases fluid, in other cases glassy, and in a few gaseous. A few translucent oxide of iron specks, only visible under the  $\frac{1}{4}$ -inch objective.

No. 23. BOULDER CREEK, SILENT GROVE, NEAR MACKAY (QUEENSLAND).

A. G. Maitland's Collection.

Colour, red. Granular, allotriomorphic, holocrystalline; the contained minerals include what looks like pink orthoclase, quartz, and a little hornblende. No mica visible in hand specimen.

## RHYOLITES, Etc.

## No. 1. FERGUSON ISLAND, DAWSON STRAITS (NEW GUINEA).

Sir W. Macgregor's Collection. Sp. Gr. 2.426.

Colour, black. Vitreous, containing numerous macroscopic quartz and sanidine crystals. The crystals appear to be centres of cracking.\* Fracture conchoidal.

*Section.*—Perfectly isotropic. Glassy base, with plentiful sprinkling of colourless rods, whose angle of extinction, being parallel with the principal axes of the nicols, would indicate monoclinic feldspar microliths. Some of the feldspars are tabular, measuring about 0.1 inch in length and half or less in width, with very minute inclusions. The rods are sometimes plates, looked at edgewise, but this is not always the case; many undoubted rods occur whose arrangement discloses fluxion-structure. The quartzes are large, measuring 0.06 inch to 0.1 inch in length, and filled with gas pores, all fixed. The Drawing on Plate 66, fig. 1, exhibits one lenticular inclusion in the left-hand corner of the quartz crystal, containing upwards of forty fixed gas pores. The drawing also shows the two habits of the feldspars, tabular and prismatic. The cracks traverse the glassy base and the quartz crystal. Magnetite sparse, in well-formed octahedra. Hornblende (?) green; in three instances with enclosed crystals of magnetite; a few pale-green hornblende (?) microliths visible under the  $\frac{1}{4}$  inch. The feldspar laths are mostly stepped, but the tabular feldspars are perfectly regular. The higher powers also show the existence of deposits along the cracks of the quartzes, ramifying, and spread like the dentritic manganese deposits found in the joints of rocks. Very often these cracks pass over the margin of the quartz crystal, penetrating into the contiguous glassy base. Amongst the quartzes are many glass enclosures, whose contours are invariably rounded, but never quite spherical, and the fixed gas bubble is generally at one end.

## No. 16. CLONCURRY (QUEENSLAND).

R. L. Jack's Collection. Sp. Gr. 2.297.

Colour, black. Vitreous. Opaque.

*Section.*—A perfect glass, a little traversed by cracks, in no particular direction. A slab 0.1 inch thick is faintly illuminated between crossed nicols.

## No. 3. MITCHELL RIVER (QUEENSLAND).

R. L. Jack's Collection. Sp. Gr. 2.72.

The rock is of a bluish-gray colour, in spheroidal lumps with conchoidal fracture.

*Section.*—Light coffee-coloured glass, perfectly isotropic. Spherical bodies occur in the glass, one of which is shown in Plate 63, fig. 1. As there shown, some of these bodies are certainly crystalline, and the crystals seem to have gathered round one point as a centre, and grown outwards, absorbing the material for their growth from the glass. The microlites near the centre seem to have had the best chance, and to have availed themselves of it, for they are more distinctly crystalline than those more remote from the centre, while the great opacity, and want, apparently, of crystalline structure in the periphery, would suggest the rejection of the material that was of no use to the growth of the crystals. The clear marginal zone round the globular bodies in every case proves that they grew by the abstraction of certain substances from the glassy base. (*Vide* Plate 63, fig. 1.)† This is almost analogous to the assimilation of food-stuffs by plants and animals.

\* These cracks must be produced by the unequal contraction, on cooling, of the quartz and the glass, respectively. This suggests the question, what are the coefficients of expansion for quartz and glass?

† The zone may be due to the heat developed in the crystallization, keeping the neighbouring glass fluid, while the more remote was getting viscous. Thus no more supplies could be got for the growth of the young crystals, except from the envelope immediately surrounding the sphere, which, being less viscous, was more thoroughly drained of the material necessary for the crystal's growth.

## No. 11. MACKAY (QUEENSLAND).

A. G. Maitland's Collection.

This rock is opaque, with a dirty reddish-yellow colour, and might belong to either the obsidian or tachylite group.

*Section*.—Only shows a few completely altered feldspars and a dense opaque yellow glassy base, which is isotropic on the feather-edge. Mr. P. F. Sellheim, Under Secretary for Mines, kindly prepared this section for me.

## No. 196. SHEFFIELD (TASMANIA).

R. L. Jack's Collection.

Colour, black. Vitreous. Glass with clear little white crystals. This is by far the most beautiful example of pitchstone I have yet seen. The crystals are olivine, and they are mostly preserved in exquisitely regular forms in the glass; the faces  $oP$  (001) are wanting. The section being a little thick and the glass very transparent, together with their high angle of refraction, enables one to recognise in these crystals many of the characteristic planes of the typical olivine crystal. In this rock, students of microscopical crystallography have an opportunity of studying olivine in a perfect crystal form. Under the  $\frac{1}{4}$ -inch objective the olivines are seen to include glass with fixed glass bubbles. The glassy base carries nothing else but opaque dusty matter in spots, which is probably a darker glass nucleus fringed with dusty matter, in whose neighbourhood gas bubbles are commonly found. The glass has bubbles at tolerably regular intervals, and in one or two cases, bubbles are strung out in shapes or outlines.

The microlites are very small, and play no great part in the constitution of the rock. They are tabular feldspars, not unlike the New Guinea feldspars in obsidian described in the No. 1 of the Rhyolites. (*For Drawing see Plate 64, fig. 2.*)

## No. 58. MACKAY (QUEENSLAND): SELECTION No. 1642.

A. G. Maitland's Collection.

Colour, light-brown. Vitreous. Fracture conchoidal, with strongly marked fissure planes, not unlike slate in this respect, rendering it difficult to mount when the section is removed from the grinding-slip. Under a lens, the rock is seen to carry numberless whitish-yellow granules, which appear as yellowish patches on the plate.

*Section*.—Isotropic glassy base filled with most delicately matted microlites. In the plate they appear too white; the real colour is a faint yellow. By reflected light they have just the colour and sheen of the hair of a fair young child. They mark the fluxion, which would otherwise be invisible. I cannot suggest a name for the yellow patches, which are amorphous and well distributed, often enveloping the smaller feldspars.

The two ovate bodies in the sanidine crystal are composed of the same substance, and are between the two faces of the sanidine section, as verified by the micrometer-screw.

The feldspars are fairly fresh sanidines. The extinction-angle of the sanidine in Plate 62, fig. 2, with reference to the crystal edge, is  $24^\circ$ , so that the section must be cut slightly oblique to the clinopinakoid (010), since, were it exactly parallel, it would be about  $21^\circ$ .\* The rock is not quartzless, but only three small rounded quartzes occur in a section  $\frac{1}{75}$  inch square.

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\* Rosenbusch. *Physiography of the Rock-making Minerals*, p. 281.

## No. 108. NELL ISLE (NEW GUINEA).

Sir W. Macgregor's Collection. Sp. Gr. 2.407.

*Section.*—A greyish glass filled with somewhat large felspar microlites, which mark the fluxion-structure, as in Plate 61, and Plate 62, fig. 1. But even if the microlites were wanting the fluxion would still be well marked by the dusty matter with which the glass is charged. The felspars are very clear, almost limpid, and generally of a tabular habit; though some are prismatic, like the felspar, abutting on the olivine crystal in the three figures on Plates 61 and 62. A felspar is shown thereon close to the margin, which is slightly inclined to the plane of the section. It is one of the tabular crystals, which, hading away from the olivine, has passed through the other side, where it has been ground off with the slice. Sanidine, twinned on the Carlsbad type, is pretty common, and exquisitely limpid. An olivine crystal is represented in each drawing, abutting on a felspar, and the structure of the glassy base, shows fluxion, as marked both by the microlites and the dusty matter. All three are magnified forty-two diameters—(1) polarized between crossed nicols, (2) with polarizer only, and (3) between parallel nicols respectively.

The roughness of the olivine is shown in Plate 61, fig. 1. The black crystals on the margin and in the interior of the olivine are either magnetite or titanite iron, more probably the latter. Under the  $\frac{1}{4}$ -inch objective the microliths are peculiarly numerous. They can be divided into two classes,—first, a large form of microlite, as a rule measuring about  $.0005 \times .004$  inch, which are always stepped like the drawing given in Rosenbusch\*; and, second, hair-like microliths, which, however, are not trichites, being transparent. The brownish-grey wave flowing over the felspar, shown in the drawings, is very rich in these minute microliths. The feathered edge of glassy base on the other felspar, just peeping out at the surface, on the right-hand side of Plate 61, fig. 2 (also showing in Plate 62, fig. 1), becomes very useful, as it enables us to get a clear view of these small bodies without the image getting blurred by a background composed of the same bodies, in different azimuths. In one of the clearest and most limpid of the sanidines is a very curious growth of what I take to be a glass inclusion. The growth starts from a point on the margin of the crystal, and branches out not unlike a fern, but that the divergent branchlets are clubbed at the end, and are a pale hyacinth colour.

## TRACHYTE.

## No. 24. GLADSTONE (QUEENSLAND).

R. L. Jack's Collection, Sanidine Trachytes. Sp. Gr. 2.79.

Colour, dirty whitish-red; with somewhat large crystals of sanidine. Very porous, with a few small cavities not unlike the smaller holes in a sponge.

*Section.*—Ground-mass plagioclase, showing fluxion-structure; quartz in very small allotriomorphic grains; sanidine, clear. One sanidine crystal is well marked with curved markings as drawn by Rutley in the "Study of Rocks" (p. 96, iii. edition) and sometimes tabular, being parallel to  $M$ ; at other times the sanidines are twinned on the Carlsbad type. By reflected light one sees a very thorough sprinkling of the whole slice with brownish-red ferritic matter, and a whitish-yellow substance, both amorphous. Only the sanidines escape the peppering.

The slice being somewhat thick it is difficult to make out the glass that ought to be present. The only glass observable is that lining the interior of cavities.

\* Physiography of the Rock-making Minerals.

## MACKAY DISTRICT.

The following eleven rocks from the Mackay District, together with the very excellent sections thereof, were kindly lent me by Mr. A. G. Maitland. They are, without exception, the thinnest sections described in this Paper, having been sliced in London by Mr. Cuttall, of Kentish Town. Drawings and sections showing the mode of occurrence of the rocks in question, given in Mr. Maitland's "Report on the Geological Features and Mineral Resources of the Mackay District," \* are reproduced in Plate 46, figs. 1 and 2, of this Work.

## (1) FROM A GAP ON THE NORTH SIDE OF MOUNT JUKES. Sp. Gr. 2·490.

Colour, red, blotched with white specks.

*Section.*—Shows granulitic quartz, the grains about ·01 inch; comparatively very large orthoclase, as Carlsbad twins, the largest reaching ·08 inch in length. These feldspars are dusty with ferrite, which gives the rock its colour. They are all kaolinized, and but for the exceeding thinness of the section could not be identified. No plagioclase. A few crystal wrecks with grains polarising in high colours on the margin of holes originally occupied by a primary crystal. These grains have a clean bright aspect in ordinary light and might be epidote or olivine. A good deal of opaque oxide of iron incysts these brilliant specks. Under the  $\frac{1}{4}$ -inch objective, the quartzes have a few inclusions; some may be glassy, others are certainly fluid with moving bubbles. (*Vide* Mr. Maitland's "Report" and Section on Pl. 46, fig. 1.)

## (2) MOUNT MARTIN, JOLIMONT CREEK. Sp. Gr. 2·570.

Colour, dirty brown. Fine-grained. The hand specimen looks like a felsite. There are no porphyritic crystals.

*Section.*—Ground-mass a felt of microlites, without any glass, but between crossed nicols feebly illuminated. Feldspars much changed, packed with granules, which are the only points of illumination throughout, the rest of the section being a dark-lavender colour. The granules may be epidote. Orthoclase was a constituent mineral of the rock. Magnetite (or titanite iron), with a little apatite, is present in small quantity, but at fairly wide regular intervals. One hexagonal section of the latter measures about ·10 inch.

## (3) MOUNT MANDARANA, "THE LEAP." Sp. Gr. 2·498.

A white rock, speckled with small black grains and sanidine; highly porous when applied to the tongue.

*Section.*—The ground-mass is made up of a little granular quartz and numerous feldspar laths, and is holocrystalline. The macroscopic sanidine (Carlsbad twins) is perfectly limpid and shows the faulting along the suture, the boundaries not participating in the apparent movement, as pointed out by Rutley.† Under the  $\frac{1}{4}$ -inch objective, the black specks turn out to be grains of deep-green mineral, with marked differences of absorption when viewed with polarizing prism. With these specks, apatite, and perhaps magnetite, is associated in fine grains. No fluxion-structure. In the feldspars of the ground-mass is one beautiful spherulite, the arms measuring nearly ·03 inch, but I cannot find another in the whole section, which is seven-eighths of an inch in diameter. Mr. Maitland says :—

"One of the most conspicuous examples of the lavas is to be found at Mount Mandarana, better known as the Black Gin's Leap, close to the Bowen Road, about twelve miles north-west of Mackay, where it forms a broad table-like mass, rising to a height

\* Brisbane : by Authority : 1889.

† F. Rutley. The Study of Rocks, iii. Edition, page 44.

of 650 feet, by corrected Aneroid, above the level of the Road. The rock of which the Leap is made up is lithologically a trachyte, and may be generally described, when examined with a lens or the unaided eye, as consisting of a light-coloured porous matrix, in which crystals of sanidine and minute crystals of what appear to be hornblende are embedded. It is seen\* to rest upon black shales, at a point in a gully flowing from the north-west corner of the mountain three hundred feet above the Road; at the junction of the two the shales for a few inches are slightly hardened. The lower portion of the sheet is made up of rudely hexagonal curved columns, the outward curvative being northwards. The structure of certain parts of this rock would seem to imply that in reality it is a succession of lava-flows of variable thickness. The estimated thickness of the sheet is not less than 350 feet."

(4) SUBAQUEOUS TUFF, ALLIGATOR CREEK, SAINT HELENS, MACKAY. Sp. Gr. 2.618.

This is a white porous rock, with reddish oxide of iron in strings and lenticular veins. The section is cut transverse thereto.

*Section.*—All but quartzless, the grains being very few, small, and sparse, with matted plagioclases in the ground-mass, the laths being clouded and ill-formed, measuring under .01 inch in length. One or two much altered porphyritic feldspars occur, with traces of many lamellæ. Dusty specks of a mineral polarising in higher colours occur throughout the section, but they are too minute to resolve with the  $\frac{1}{4}$ -inch objective. The highest colour produced between crossed nicols in the ground-mass is slate-grey.

*N.B.*—Hydrochloric acid failed to produce effervescence except where the section cut through an iron speck, when a very slight effervescence ensued, making one suspect the presence of siderite.

(5) MOUNT JUKES.

This rock is similar to (1) except that the colour is lighter, it being white. The feldspars glisten when the hand specimen is turned about in the light, owing to the cleavage planes of the feldspars catching and reflecting the rays.

*Section.*—By reflected light there is hardly any ferrite, and the orthoclase is less kaolinized. The quartzes limpid, as in (1). The rock is a perfect example of holocrystallinity. There are but two constituent minerals—orthoclase in Carlsbad twins, dusty from kaolinization which is rudely parallel to the cleavages, the latter making angles with the plane of composition; and the quartzes, which have marked dihexahedral inclusions, liquid, glassy, and gaseous. In some of the quartzes are moving bubbles. Others with the dark margin, occur, denoting gaseous inclusions. The quartzes average .01 inch, the smallest being .002 inch, and the orthoclase sometimes .03 inch long by .02 inch or less broad. Two or three jet-black lustrous grains, and a few longer or rod-like of the same substance were not identified. Mr. Maitland says:—

"Another denuded wreck of an old volcano is to be found in Mount Jukes, some 1,800 feet above sea level, and situated on the bank of Neilson's Creek, and about twenty miles distant from Mackay in a north-westerly direction. The mean specific gravity of the rock, from specimens in different parts of the mountain, was found to be 2.55. Different parts of the mass present different characters, but generally two varieties can be recognised—

- (a) A coarse-grained rock in which a matrix can scarcely be said to exist; and
- (b) A second in which crystals of sanidine and plagioclase are embedded in a microcrystalline base, which, with the aid of a lens, is seen to be made up of small crystals and crystalline grains of sanidine and hornblende (?).

\* See Pl. 46, fig. 1. (A.W.C.)



"The former variety, owing to its coarse grain, would be called a nevadite, whilst the latter would be best described by the term sanidine-trachyte; both, however, are merely varieties of one and the same rock. The rock is intrusive through the volcanic series, and sends out here and there dykes of no great thickness, and of a somewhat similar character to the rock forming the main mass. Hardly any apparent alteration has taken place in the rocks through which the mass has burst."

(6) MOUNT MANDARANA. Sp. Gr. 2.46.

Colour white, with a tinge of blue. Microgranitic, holocrystalline. The whole rock is made up mainly of ground-mass, there being very few porphyritic feldspars.

*Section.*—Shows a little corroded mica, some minute specks of a mineral polarizing in high colours, with a greenish, sometimes colourless, tint. A very few porphyritic feldspars, probably oligoclase. A very regular scattering of grains of hæmatite (or some translucent iron oxide) and a little interstitial glass spread over an area of .05 inch, and not occurring anywhere else in the section. The mica shows complete absorption for rays vibrating parallel to lamella when the section is normal thereto.

(8) PINNACLE, HILLSBOROUGH. Sp. Gr. 2.49.

Colour, brownish-red. With marked fluxion-structure, porous and very fine-grained.

*Section.*—Ground-mass highly feldspathic, with well-marked spheroidal structure, and but little quartz. A few specks of a mineral polarizing in high colours, and a few water-clear sanidines. The angle of extinction right and left of the twinning line for a twinned crystal is—right  $9^{\circ} 40'$ , left  $19^{\circ} 30'$ ; this crystal measures .12 inch long by .04 inch broad, and is perfectly limpid. There are certain lines in the section, on either side of which the microlites arrange themselves transversely. Whether this is a result of fluxion is not certain. I have not seen fluxion-structure exemplified in this way before. Mr. Maitland says:—

"Another fragment of rock of this class is seen capping the Finlayson Hills, 22 miles north-west of Mackay, and about  $1\frac{1}{2}$  miles from the sea-coast, where it forms a sugarloaf-shaped peak, resting on granite, and rising to a height of about 100 feet above the summit of the hills.\* The rock has a matrix of a purple-grey hue, with well-marked banded or ribboned structure, in which the lines of flow can often be seen to bend round the larger sanidine crystals embedded in the base. As a whole, the rock is much more compact than the Mandarana trachyte, and, like it, forms rudely hexagonal columns."

(9) ALLIGATOR CREEK, SAINT HELENS.

Fine-grained brown rock.

*Section.*—By reflected light shows ferrite, white dusty specks, and occasionally pyrites, without magnetite. Between crossed nicols there is no interstitial glass, and it is difficult to say whether the much kaolinized feldspar laths are embedded in a felsitic mass or not, since although, as a whole, the laths are distinct, yet when a higher power is used all definition disappears, the edges merging into a fine-grained granular aggregate, sometimes polarizing brilliantly. The feldspars are highly altered. Many of them are filled with irregularly scattered grains of a very doubtful epidote. The rarer sanidine is pellucid as usual. Calcite is occasionally seen in small grains in twinned lamellæ. The porphyritic crystals are represented by two or three wrecks of feldspars,

\* See Pl. 46, fig. 2. (A.W.C.)

so changed as to be impossible to identify. Another remnant of what has been a large prism, measuring .08 inch by .01 inch, is crossed by yellowish-red bars of a non-fibrous but rather granular structure, feebly anisotropic. If this crystal could be restored and identified, great light would be thrown on the whole matter of the origin and life-history of this rock. As a concluding observation, the proximity of calcite to the relics of this crystal and its possible occlusion amongst the somewhat heterogeneous mass of secondary mineral matter is to be noted.

(10) SEAFORTH HILLS, WEST SIDE, MACKAY. Sp. Gr. 2.48.

Colour, dirty grey, with a tinge of blue. Quartz is the only porphyritic mineral, and is embedded in a fine-grained pasty-looking ground-mass. The whole rock is sprinkled with fine blackish grains. The quartzes are very brilliant.

*Section.*—By reflected light, the ground-mass consists of kaolinized feldspars, not lath-like, but granular and pretty uniform. The black grains are innumerable, not sharp, but irregular, and often surrounded by ferrite. Under the  $\frac{1}{4}$ -inch objective the fresh feldspars are twinned, and might be orthoclase or sanidine. Owing to dusty matter and kaolinization, it is difficult to identify these very minute feldspars, particularly as they are too small to be inspected under any lower power than the  $\frac{1}{4}$ -inch. There is no interstitial glass or fluxion-structure. Quartz is the only porphyritic mineral, and is rounded, showing, in two or three cases, the “bays, inlets, and islands” peculiar to the quartzes of the rhyolites and porphyrites. The quartzes carry liquid, gaseous, and glassy inclusions. Mr. Maitland says:—

“Near the head of Niddoe’s Creek, one of the watercourses draining the western side of that range of hills lying between the Main Range and the Coast, a trachyte lava of a somewhat different character is seen dipping south-east at an angle of 12 degrees, and resting upon the sedimentary rocks of which this range is made up. Lithologically the rock may be called a quartz-trachyte, and throughout it presents a great uniformity in its physical characters; it is made up of a light-grey, porous matrix, in which quartz, sanidine, and small specks of what appear to be hornblende are embedded.”

(11) THE PINNACLE, SAINT HELENS.

A nearly white rock, weathering red, very fine in grain, and without any porphyritic minerals.

*Section.*—By reflected light. Fine-grained, without any porphyritic minerals, with a few green and much corroded fragments and many minute specks of a reddish semi-translucent hydrated oxide of iron. The base is microlitic, without any pasty matter whatever, and is built up of orthoclase, plagioclase, and quartz, and the greenish mineral may be mica very much corroded. Mr. Maitland says:—

“In the Parish of St. Helens, on the south bank of Alligator Creek, a lofty ridge of mountains, the Pinnacles, which form a corry, encircling one of the branches of this creek, a great thickness of lava occurs. The rocks are trachytes of a brownish-grey colour, and with which fine-grained trachyte tuffs are associated. The lava-sheets have their steeper faces southwards, and appear to dip in a general northerly direction. One of the sources from which some of these lavas and ashes have been ejected appears to be Mount Barron, a steep, triple-peaked mountain, the highest summit of which is about 2,000 feet above sea-level, and which is almost surrounded by the head-waters of St. Helen’s Creek. (Section IV.) The rock of which this mass is made up is greyish-white in colour, and somewhat porous, with a mean specific gravity, as determined by a Walker’s Specific Gravity Balance, of 2.56. In the matrix, small crystals of sanidine

and minute specks of a black mineral—probably hornblende—can be recognised. Throughout the whole mass, the rock retains very much the same character. The mountain rises perpendicularly from the alluvial flat on the north bank of St. Helen's Creek, and in Barron Creek the mass is seen to be intrusive through an 'orthoclase porphyry' upon which the sedimentary strata are seen to rest. No perceptible amount of alteration was detected in any of the sections in which its intrusive character was observed."

#### BASALT.

##### No. 2. GOODENOUGH ISLAND, MORESBY STRAIT (NEW GUINEA).

Sir W. Macgregor's Collection.

*Section.*—Vesicular, with minute augite and felspar crystals visible to the naked eye. Augite crystals are plentiful, with glass and magnetite inclusions. Mr. Maitland, who has recently visited New Guinea, suggests that the augite may have to be referred to enstatite; in which case the rock would be classed among the andesites. The sanidine crystals show growth by accretion in a very beautiful manner. The ground-mass is so opaque that minute plagioclase crystals not thick enough to reach through and touch each surface of the section do not appear by transmitted light at all, while by reflected light a very large number of these minute pellucid crystals can be observed.

##### No. 173. PALM ISLAND.

H. C. McDonald's Collection. Sp. Gr. 2.622.

Colour, speckled greenish-brown. The specks are yellowish. The rock has a compact texture.\*

*Section.*—This rock is so much decomposed that its section does not reveal very much. Its constituent minerals are augite and felspar. Apatite (in considerable quantities) and magnetite occur as accessory minerals.

The augite is much cleaved and shattered, the basal sections having very well-marked cleavage, parallel to 110.

The felspars must once have been of great beauty (and their even size and perfect twinning is still discernible). They are associated with a green mineral of secondary origin, probably chlorite, plentiful, not regular in outline, not pleochroic, differences of absorption *nil*, between crossed nicols appearing a speckled yellow-green; the specks do not extinguish uniformly.

##### No. 15. NORMANBY REEFS, COOKTOWN (QUEENSLAND).

F. Bauer's Collection. Sp. Gr. 2.808.

Colour, black, with reddish spots. Compact, slightly vitreous, fine-grained.

*Section.*—Ground-mass abundant, with idiomorphic hyalosiderite, or perhaps fayalite, and plentiful hydrous oxide of iron, pseudomorphous after olivine. The latter mineral exhibits all the stages of decomposition, some examples being quite fresh and coffin-shaped, others having a deep-red margin and clear interior, others being only specks, and others being without a trace of the original olivine. The olivines are the only crystals of any size in the rock; they measure from .04 inch to .06 inch in length. The rough look, owing to a high index of refraction, is marked. In one or two rare cases the red envelope round an olivine is packed with magnetite. There are no inclusions. The drawing on Plate XIX. of Rosenbusch's "Physiography of the Rock-making Minerals" illustrates these olivines exactly. The ground-mass is peppered

\* Mr. McDonald stated that this sample was taken from a dyke passing through a "conglomerate" dipping towards the sea.

with fine black lustrous grains, which are magnetite, as was found by testing a washed sample of the pounded rock, and trying it with a magnetised sewing needle in a watch-glass full of water under the microscope. There is a great deal of interstitial glass and fine felspar microlites. Leucite occurs sparsely in small six and eight-sided sections. Often in these crystals there is a central mass of inclusions consisting of magnetite and microlithic felspars, leaving a glass-like hexagon or octagon perfectly free from any inclusions, but with the angles generally rounded. But for this feature I might have passed it over, but when once seen in the slice it becomes striking. The wearing of the angles of leucite is noted by Teall.\* No quartz or augite, and no fluxion-structure.

No. 75. RUSSELL RIVER (QUEENSLAND).

R. L. Jack's Collection. Sp. Gr. 2.864.

Colour, black. Compact. The fine crystals cause it to sparkle in the light. The weathered surface is earthy, and coloured dirty yellow. Absorbent to the tongue.

*Section.*—Ground-mass glassy, matted with felspars, and perhaps very minute augite (?) grains, sharp grains of magnetite and granular serpentine, &c. The section is not thin enough for accuracy in these determinations. Olivine in fairly large crystals, undergoing alteration to serpentine, is the only porphyritic constituent. The felspar microlites in the ground-mass measure about .01 inch by .001 inch. Plate 65, fig. 1, shows the olivines, the largest of which has a hole through it, which, of course, appears black between the crossed nicols. The drawing shows the confused aspect of the base, owing to the thickness of the section. Quartz absent.

No. 167. SURPRISE CREEK, HERBERTON (QUEENSLAND).

R. L. Jack's Collection. Sp. Gr. 2.64.

\* Colour, gray, with reddish-brown specks. Vesicular, with zeolites.

*Section.*—Very rich in augite grains, which are about .001 inch in diameter, plagioclase felspars and delicate microlithic needles permeating the felspars. No quartz, and very little glass. The plagioclases are usually .02 inch long, and each is banded three or four times. The only porphyritic crystals are much cracked. Augites invariably enveloped in a red mineral of secondary origin. The augites carry minute enclosures of glass and magnetite. Sometimes the secondary mineral has completely taken the place of the augite. No orthoclase. Rich in magnetite, which occurs as sharp grains. The rock would be better classed as anamesite than as basalt, all the constituent minerals being of large size.

No. 169. "VOLCANIC HILL," IN PETERSON'S POCKET, HERBERTON (QUEENSLAND).

R. L. Jack's Collection. Sp. Gr. 2.291.

Colour, black. Vesicular, with grey streak.

*Section.*—Very vesicular, with large, fresh, much-cracked augite, sections of which, parallel to clinopinakoid, have an angle of extinction of  $25^{\circ} 30'$ . Very fine-grained ground-mass of microlithic felspars, and literally swarming with magnetite. Magnetite and glass are the only enclosures in the augite.

## No. 170. ATHERTON'S CREEK, HERBERTON (QUEENSLAND).

R. L. Jack's Collection.

Colour, greyish-black. Very compact.

*Section.*—May be described in the same language as No. 167, except that the minute felspar microliths are wanting, and the ground-mass is richer in augite granules.

## No. 171. ATHERTON'S CREEK, HERBERTON (QUEENSLAND).

R. L. Jack's Collection. Sp. Gr. 2.733.

Colour, purplish-grey. Small vesicles.

*Section.*—The ground-mass is more glassy than in the preceding sample, No. 170, and the augite is microgranulitic, with a little magnetite in the ground-mass. The porphyritic augite is precisely similar in every respect to the last. The angle of extinction on the clinopinakoid subtends an angle of  $24^\circ$  with the edge of the crystal.

The felspar microliths are long (about .92 inch), and seldom show more than two stripes. They gracefully sweep past the obstructing augites, giving a fairly well-marked fluxion-structure. It is by far the most interesting of the basalt collection, and the section is peculiarly thin.

## No. 251. MITRE ROCK (NEW GUINEA).

Sir W. Macgregor's Collection.

Colour.—A dark greenish-black rock with yellow specks.

*Section.*—Ground-mass plentiful, consisting of a glass with innumerable felspar microlites and sharp grains of magnetite. The felspars do not exceed .001 inch in length, and the magnetite grains, which are wonderfully equal in size, measure .0002 inch in diameter. Fine black dusty matter makes the glass obscure, but under the  $\frac{1}{4}$ -inch objective the constitution is resolved as given above. The porphyritic minerals are plagioclase and augite, both very fresh, particularly the felspars. Sanidine in Baveno twins with perfect zonal structure; also in Carlsbad twins. The best example of the plagioclases several times twinned show angles of  $26^\circ$  and  $24^\circ 30'$  between the respective axes of elasticity and the traces of the twinning plane  $M$ , so that the section must be nearly normal to that plane. It is not certain whether this section cuts the basal pinakoid or the clinopinakoid, but, whichever it may be, the formula of the mixture cannot be less than  $Ab\ An$ ,\* according to Rosenbusch's table quoted in the granite series. Zonal structure occurs in the plagioclases.

The augite is in large crystals, averaging .06 inch, showing marked cleavage. The angle between cleavage and an axis of elasticity is  $28^\circ 30'$ . The augites are but little altered. In some cases serpentinization seems to have started. The inclusions are glassy and gaseous. No moving bubbles.

## No. 214. LOLWORTH RUN, FROM THE FOOT OF THE GRANITE RANGE, HOMESTEAD, CAPE RIVER (QUEENSLAND).

W. H. Rands' Collection.

A black, very fine-grained, compact rock. Carries no glass or pasty matter in the ground-mass; might be a dolerite. The augite is microgranulitic. The felspars are much striated. Compared with a section in a collection sold by R. Fuess, of Berlin,

\* Where  $Ab$  represents albite and  $An$  anorthite. *Vide* Note on Rosenbusch's Felspar Formulæ at end of Chapter.

from Spiddal, it would be classed as a diabase, and, accepting Allport's view that diabase is really an altered condition of dolerite, it would be placed amongst the diabases, following after the dolerites. (Professor Wadsworth places melaphyr, diabase, gabbro, and many of the diorites under this head, so it may remain here.)\*

*Section.*—Much augite in small grains, cracked; little olivine, porphyritic augite; and exquisitely clear pellucid plagioclase feldspars, showing several lamellæ. The angle between the extinctions of the lamellæ, right and left, is about  $30^\circ$ .

Nos. 51, 52, 53, 60, and 64. THE BURDEKIN RIVER (QUEENSLAND).

A. W. Clarke's Collection.

No. 266. MOUNT RAZORBACK, UPPER BURDEKIN (QUEENSLAND).

A. Gibb Maitland's Collection.

No. 267. MOUNT LANG, UPPER BURDEKIN (QUEENSLAND).

A. Gibb Maitland's Collection.

Sp. Gr. of No. 266, 2.667; of No. 267, 2.477.

The first four rocks are from three well-known points on the Burdekin River—viz., the "Top Rocks," the "Lower Rocks," and the Crossing at Great Sandy Creek. They are all vesicular black basalts.

The weathered rocks are often found with a white secretion in the vesicles, probably zeolites.†

*Section.*—The ground-mass is made up of large plagioclase laths, .001 inch by .02 inch, mostly stepped, and polarizing in high colours for feldspars, and some doubtful sanidine. The walls of the vesicles are lined with glass, in which occur a few very minute specks, faintly luminous, but otherwise there is little glass and no fluxion-structure. Magnetite in fine grains, plentiful. Augite in very small grains and plentiful. The porphyritic minerals are olivine and augite. Along the cracks and fissures of the former is a secretion of ferrite. The augite inclusions are glassy, with fixed bubbles, and magnetite.

Unfortunately, the thickest section was that from which Plate 66, Fig 2, was drawn, so that the slice is too opaque, and in those crystals which do allow the light to pass the colours are too high. However, in the drawing the olivines come out very well.

No. 266 differs from the preceding in the development of the transparent hydrated oxide of iron which incrusts some of the olivine, so that hyalosiderite or fayalite must be reckoned amongst the varieties of olivine present in the rock. Certainly a few sanidines exist, and a little glass occurs. The rest of the rock may be described in the terms of the preceding note on Nos. 51, 52, 53, 60, and 64.

In No. 267, the last of the Burdekin series of basalts, some beautiful prismatic feldspars occur .05 inch by .002 inch, the angle of extinction with the edge of the pellucid crystals being  $0^\circ$  or  $3^\circ$  and  $4^\circ$ . Otherwise the same description applies as to No. 266.

No. 72. OKENDEN, MACKAY (QUEENSLAND).

A. Gibb Maitland's Collection. Sp. Gr. 2.704.

A black, fine-grained, compact rock, with greyish-white streak.

*Section.*—Microgranitic, granulitic. Plentiful magnetite. Some highly-coloured specks between crossed nicols, pointing to augite. No glass in the ground-mass, and no porphyritic constituents whatever.

\* M. E. Wadsworth. Preliminary Description of the Peridotites, Diabases, and Andesytes of Minnesota, 1887.

† Black ants build their nests in the vesicular cavities of this basalt.

## No. 29. NEAR BATHURST (NEW SOUTH WALES).

The late Mr. C. S. Wilkinson's Collection. Sp. Gr. 2.993.

A black, fine-grained, compact rock, the faces of some of the constituents glistening; weathering yellowish-grey, and spotted; rarely with zeolites.

*Section.*—The ground-mass contains fine lath-like feldspars, a little glass, porphyritic augite, and olivine with plentiful black grains of magnetite or titaniferous iron. The feldspars show fluxion-structure, arranging themselves in little streams dividing before, and closing up after meeting an obstructing porphyritic crystal in the flow. The feldspars are about .01 inch in length. A greenish secondary mineral matter is often secreted along the augite cracks. Magnetite frequent, enclosed in the augites.

## No. 30. BATHURST (NEW SOUTH WALES).

The late Mr. C. S. Wilkinson's Collection. Sp. Gr. 2.951.

Black, compact, with occasional spots of zeolites. Weathering to a yellow ochreous colour.

*Section.*—The ground-mass contains fine lath-like feldspars, with very minute grains polarizing in high colours, probably augite, and very little glass. The porphyritic augites are as a rule fresh, though in some cases the secretion of greenish matter is to be observed along the very irregular cracks. Some water-clear plagioclase feldspars occur with a very wide angle of extinction between broad and handsome lamellæ, polarizing in a low colour. The highest angle of extinction observed was  $63^{\circ} 30'$ , and the lowest  $32^{\circ}$ . The fluxion-structure is even more prettily marked than in No. 29. One of the augites shows distinctly cross cleavages (which, however, are not very regular) parallel to the face *oo P*. Another augite shows twinning in an interesting manner, there being three lines along the suture, as in the section of the Gympie augite illustrated on Plate 65, Fig. 2. The whole section swarms with magnetite.

## No. 31. MOUNT SASSAFRAS (NEW SOUTH WALES). Intruding through the Hawkesbury Formation.

The late Mr. C. S. Wilkinson's Collection. Sp. Gr. 2.816.

Greyish-black. Crystals quite visible owing to reflection. No zeolitic matter.

*Section.*—The ground-mass has very little glass, and is much charged with a dirty brownish-green opaque matter. Magnetite and plagioclase feldspars. On the margin of one of the olivines is a stellate group of secondary secretions, which polarize in the aggregate, one portion certainly spherulitic. Augite and olivine occur porphyritically, the latter a pinkish-brown, and dark, polarizing in high colours, and much pierced and riddled by the feldspars. Crossing the junctions are fine needles, probably of apatite. The latter also abounds throughout the ground-mass. Magnetite is plentiful, as is probably also titaniferous iron.

A rather large augite crystal is traversed by cracks, along which there are secondary deposits. Their pleochroism is exceedingly remarkable, in some cases sky blue, yellow, and green, very distinct. The periphery of this large crystal is marked by a dark-brown zone, and extending radially into the contiguous ground-mass is a fine, delicate, semi-translucent, aggregately-polarizing fringe. Arranged in the same way under the  $\frac{1}{4}$ -inch objective, this fringe is seen to be composed of fine microliths, clear, and rather short, very much crowded together, owing to which there is no extinction in any azimuth. The augite is rich in gaseous pores.

## No. 309. VICTORIA: OMEO.

P. Platt's Collection. Sp. Gr. 2·71.

Greyish-black. Compact.

*Section.*—A compact basalt, with lath-like feldspars, doubtful olivine, and grains of magnetite. A yellow isotropic glass occurs amongst the crystals. Fluxion-structure. A yellow envelope, precisely similar to the above, encloses an augite crystal, which has symptoms of spherulitic structure.

## No. 310. BALLARAT (VICTORIA).

P. Platt's Collection. Sp. Gr. 2·54.

Greyish-black. Compact basalt from core of diamond drill.

*Section.*—The texture is nearly the same as the above (No. 309), but the slice is too thick for much keen observation. The yellow isotropic mineral is rare.

## DOLERITES.

## No. 47. GOUGH (NEW SOUTH WALES).

The late Mr. C. S. Wilkinson's Collection. Sp. Gr. 2·964.

Black. This is a compact basalt, speckled with white crystals.

*Section.*—The rock is granular, idiomorphic and holocrystalline. The plagioclase feldspars are often ·03 inch by ·002 inch, and the majority are a pale-lavender, with very small angles of extinction between the sets of lamellæ, which latter are repeated many times in all of the crystals. Other plagioclases have high angles of extinction, and polarize in higher colours—*i.e.*, in light yellow and orange. The latter often exhibit undulose polarization.

Olivine somewhat large and fresh. Augite granular, with granulitic structure as defined in Professor Hutton's Paper before alluded to. Magnetite sparse. Very little apatite, and no interstitial glass.

## No. 35. WOLLONGONG (NEW SOUTH WALES).

The late Mr. C. S. Wilkinson's Collection. Sp. Gr. 2·778.

Colour, brownish black.

*Section.*—Semi-crystalline, the lath-shaped feldspars being separated from each other by felsitic matter. Magnetite and perhaps titaniferous iron most abundant. Augitic matter in very small granules, and not abundant. There is no interstitial glass.

## NOS. 18 AND 19. SELLHEIM SILVER MINES (QUEENSLAND).

(No. 18 is from the surface, and No. 19 from 30 feet depth.)

R. L. Jack's Collection. Sp. Gr. of No. 18, 2·854.

Colour, dark-grey, speckled with what looks like hornblende.

*Section.*—Both show similar contained minerals, with the exception of hydrated iron oxides, which are abundant in No. 18. The minerals are so altered that even on the thinnest feather-edge there is nothing very clear or worthy of description. The rock is mainly composed of lath-shaped feldspars, some being tabular and frame-shaped. Needles of apatite are plentiful, in fact I have never seen a rock-section so crowded with this mineral. In a single group of quartz crystals, there is a continuous band ·22 inch long, containing apatites, cut parallel and at right-angles to *o P*. They are of various sizes, ranging from the finest hair up to prisms ·001 inch in diameter, and from ·02 inch to ·08 inch in length.



Magnetite completes the list of constituent minerals that can be identified. The felspars are filled with a granular deposit, some grains of which polarize in high colours, and may be epidote. Some rounded grains also are to be observed in the felspars, which polarize in high colours and might be put down either as olivine or augite, more probably the latter.

#### NO. 71. THE LEAP, MACKAY (QUEENSLAND).

A. Gibb Maitland's Collection.

*Section.*—This is another rock whose mineral contents are wholly changed and altered. The ground-mass has been micro-granulitic and holocrystalline, with idiomorphic crystals of lath-shaped felspars. There are a few fairly large porphyritic orthoclase crystals, some of which are .06 inch long, twinned on the Carlsbad type, and a few triclinic felspars. The plagioclase felspars show marked fluxion-structure in the rock.

Quartz very sparse, in grains with rounded edges, carrying inclusions, some of which have fixed bubbles, and others are glassy. No moving bubbles.

A little pyrites and magnetite make up the rest of the rock.

#### NO. 21. MOUNT KINCHANT, MACKAY (QUEENSLAND).

A. Gibb Maitland's Collection. Sp. Gr. 2.816.

Colour, grey, speckled with white felspars.

*Section.*—One turns with relief from examining the ill-defined wrecks of crystals in the last three rocks to this, with its fresh, clean-cut, many-striped felspars. Epidote is in fan-shaped groups. Magnetite, much of it sharp; and apatite in fine needles.

The texture is not holocrystalline, there being a pasty mass of felsitic matter separating what would otherwise be contiguous crystals. Felspars striated many times, often over five, and once over forty times. The angle between the axes of extinction for each set of lamellæ in the largest felspar is  $27^{\circ}20'$ , and it measures .161 inch by .01 inch. Many of the tabular felspars are built up zonally.

The epidote is sometimes in rods, decidedly pleochroic; at other times it is in fan-shaped groups, merely showing differences of absorption on rotating the stage over the polarizer.

The magnetite is sometimes in sharp, clean octahedra, and sometimes rounded.

The apatite, which is sparse, is in fine needles.

#### DIORITES.

#### NO. 246. SWEDENBORG REEF, CHARTERS TOWERS (QUEENSLAND).

The Hon. H. Mosman's Collection. Sp. Gr. 2.866.

Colour, greenish-black. Speckled. Perfectly clear, fresh. Microgranular, holocrystalline.

*Section.*—The felspars, although minute, are very perfect, often twinned several times. Angles of extinction between parallel lamellæ vary from  $11^{\circ}$  to  $60^{\circ}$ . The perfect rulings of these felspars are very beautiful when viewed between crossed nicols. Hornblende in about equal proportion to the felspars, showing marked absorption and perfect intersecting cleavages when cut parallel to basal pinakoid, often punctured by apatite prisms. Magnetite and possible ilmenite common. One or two specks of titanite, being bright yellow with a high index of refraction. Perfectly colourless transparent microliths commonly occur in the felspars. Very little accessory quartz.

## No. 13. DAY DAWN P.C., CHARTERS TOWERS (QUEENSLAND).

A. W. Clarke's Collection. Sp. Gr. 2.949.

This sample of rock comes from the No. 10 level, and is almost black in colour, very fine in grain.

*Section.*—Hornblende is the prevailing mineral. With ordinary light, it is in very slender long needles which are felted together. The feldspars are plagioclase, and not clear as in the last example of diorite. No quartz, and but little magnetite.

## No. 17. QUARRY RESERVE, MOUNT ALMA, CHARTERS TOWERS (QUEENSLAND).

A. W. Clarke's Collection. Sp. Gr. 3.057.

Colour as in No. 13.

This is a very similar diorite to No. 13, being of interest only because the diorite No. 13 is from a depth of about seven hundred feet, while this is a surface rock distant about one mile from the mine.

## PORPHYRITES.

## Nos. 129 TO 151. CROYDON (QUEENSLAND).

Sp. Gr. : Mean, 2.542 ; Extremes, 2.396 and 2.640.

In the following description a good deal of ground is covered ; the notes being culled from some twenty-three rock samples collected by Mr. Jack. At one end of the series, the rock is jet-black, very compact, with conchoidal fracture, and studded with quartz whose surface of fracture is coincident with that of its matrix. At the other end of the series, the rock is milk-white with identically similar quartz. The rock occasionally shows blebs of graphite, and about the middle of the series the hand specimens appear banded with different coloured varieties of the same rock. The larger quartz grains cause waves in the banding, just as in sections of the rhyolites.

The following notes on the microscopic sections do not throw much light on these rocks, and the whole matter is in the hands of the Geological Survey Department, but they form an item of information which may not be devoid of interest:—

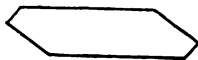
Ground-mass under the 2-inch objective shows no interstitial glass, and polarizes in a hazy way, but every illuminated speck suffers extinction in the course of revolution of the stage. Perfectly opaque, amorphous patches of a white substance (not unlike kaolin) are distributed over the slice. By reflected light these patches are seen to aggregate together. Part of the ground-mass is coarser in its crystalline structure than are other portions, and the quartzes are all more or less penetrated by it in the shape of bays, inlets, and islands. The isolated ground-mass in the quartzes is due probably to the transverse sectioning of a penetrant tongue. There are the wrecks of orthoclase crystals. The ground-mass has so penetrated and become part and parcel of the original crystals that it is difficult to speak with certainty as to whether they were sanidine.

In the quartzes are numerous glass-inclusions with fixed, and some few moving bubbles. There is a patch of faintly green granular particles mixed with the ground-mass. The green grains are very faintly dichroic (faint green to pale faint yellowish-green). The quartzes are mostly rounded on their edges and angles.

In other sections the pale-green granular flecks are seen aggregated together in what appears like the wreck of a crystal. These flecks are faintly dichroic, and in one aggregate there is possibly apatite, but it is uncertain. The *very* small green grains are sometimes numerous, and, under the  $\frac{1}{4}$ -inch objective, allotriomorphic. They are not dichroic.

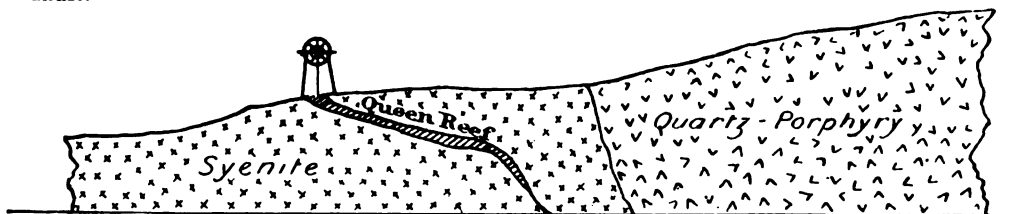
Some patches of undoubted hornblende occur, which, though not very fibrous, are too much changed to allow me to speak certainly on this point. Black, opaque

masses appear in juxtaposition with the hornblende. They are also amorphous, and may be graphite. Occasionally brown hornblende occurs, which, as usual, is very strongly dichroic. Epidote occurs amongst the altered hornblende. It is white, and polarizes of course brilliantly. Some few yellow varieties occur; and in one of the white epidote masses, a few microliths, that favour the monoclinic felspar variety, occur, shaped thus :—



In the reddish varieties of the porphyry, ferrite is plentiful.

Mr. Jack, in a letter to me, dated Croydon, 4th December, 1889, states that this rock "forms the hills lying side by side with the syenite forming the flats, and in which the reefs of Croydon proper lie. The junction runs N.W. to S.E., just a few chains off the Queen line of reef for two or three miles, and so straight as to suggest a fault."



"I have never seen the syenite intruding through the quartz porphyry, or *vice versa*. Then again the quartz porphyry shows fluxion-structure in a manner suggesting a true igneous rock. Further, the quartz porphyry at times weathers so as to show apparently purely siliceous, rounded enclosures, suggestive of an altered conglomerate. The quartz porphyry (as well as the syenite) is full of little nests of graphite, also suggestive, I think, of metamorphism."

#### NOS. 79 AND 80. GREAT NORTHERN TIN MINE, HERBERTON (QUEENSLAND).

No. 79 is from three hundred feet below the surface. It is a grey elvan, with glassy spots of quartz, and occurs as a dyke in granite.

*Section.*—Elvan with felsitic base. This is really a quartz-porphyry: a microcrystalline granite base, with porphyritic quartz. The felsitic matter, under the highest powers, carries light-green specks, quartz, and felspar, but there is no absolute certainty about these minerals except that the green specks show faint absorption when the stage is rotated over the polarizing nicol without the analyser. The ground-mass is dusty, and carries rare pyrites. The quartzes show corrosion and rounded contours, with the usual bays, inlets, and islands filled up with the ground-mass. These quartzes are from 0.2 inch to 0.4 inch, and one is 0.8 inch in diameter. The specific gravity of the rock is 2.603.

No. 80 is from the same dyke cropping out at the surface, and is precisely the same as No. 79, but for the reddish colour due to weathering. The specific gravity of the rock is 2.559.

*Section.*—Felsitic matter much more opaque and dusty, and quite impossible to resolve. Porphyritic quartz, whose edges and angles are much less rounded and corroded than is the case with No. 79. They measure from 0.3 inch to 0.5 inch. The felspars are represented by one much altered twinned plagioclase, whose angle of extinction, between the two sets of lamellæ, is only 1° or 2°. It is 100 inch long, is often twinned,

and the whole space occupied by the late crystal is now filled by little specks of a highly-coloured mineral (between crossed nicols) in addition to dusty kaolin. The specks may be mica or epidote.

NO. 95. **ATHERTON'S CREEK, MACKAY (QUEENSLAND).**

A. Gibb Maitland's Collection. Sp. Gr. 2.66.

Colour grey, with small black specks and small flesh-coloured feldspars.

*Section.*—Feldspathic spherulites, contiguous, without interstitial paste, but sometimes with intervening microgranulitic quartz. Dusty porphyritic feldspars, packed with specks showing high colours between crossed nicols. These specks are distributed in a base whose definition is hazy and suffers partial extinction on rotation of the stage, while some of the specks remain illuminated in all azimuths. The feldspars measure from .01 inch to .02 inch, and some show faint twinning bands. Occasional porphyritic quartz, very much corroded. Some ill-defined chlorite and very sparse apatite.

NO. 5. **GYMPIE (QUEENSLAND).**

R. L. Jack's Collection, "Greenstone." Sp. Gr. 2.49.

Colour green, with white streak, and speckled with slightly deeper green spots.

*Section.*—It is not easy to describe this rock. It is highly metamorphosed, no component mineral being now in its pristine state, with the exception of a few small augities, whose sections are parallel with the basal pinakoid, and show cleavage parallel to prism-faces (parallel to 110). They are the only shining lights of the section, except doubtful epidote grains. There is a pasty ground-mass filled with feldspar microliths. The porphyritic feldspars are impossible to name: they merely present confused kaolinized patches with opaque specks, which, by reflected light, are found to be milk-white.

The hornblende or augite cavities, on the other hand, show light, bright-green, very translucent patches, polarizing in very low colours, almost requiring the quartz plate to discern, in many cases associated with a little apatite. This light-green mineral of secondary origin might be chlorite, or, as Mr. Jack suggested, viridite. In one or two cases there is a lattice structure, polarizing in vague blue slate colours, but it is ill-defined.

At first sight the section looks uncommonly like a porphyry. The lattice structure may possibly be serpentinous, and derived from the pre-existent augite.

NEW SOUTH WALES. Marked "Intrusive Dyke-stone from the Peak." Plate 60.

The late Mr. C. S. Wilkinson's Collection.

Colour, dirty brownish-red, coloured with green spots.

*Section.*—The chief interest of this rock lies in the abnormal development of epidote, which, in fan-shaped groups and green laths, fills the space probably at first occupied by augite. The colours between crossed nicols are very high. The index of refraction is high, and the pleochroism is fairly marked, so that there is little doubt about the presence of epidote; but there is an uncertainty with regard to the percentage of these epidotes, for in no single instance has the change been incomplete. The shape and angle of the prisms suggest augite. Originally the crystals were perfect in shape, since the outlines are even now clear and sharp. The prism-angles I made out to be about  $88^\circ$ . There is abundant apatite, and there are also transparent red grains, while ferritic matter is developed with and alongside of the epidote. The rest of the section calls for little description, the ground-mass being microfelsitic. The porphyritic

felspars are large, measuring from .05 to .1 inch long. The angle between the axes of extinction for the two sets of twinned lamellæ in the largest felspar shown in Plate 60 is  $14^\circ$ .

No. 177. -MOUNT BISCHOFF (TASMANIA).

R. L. Jack's Collection. Sp. Gr. 2.783.

Colour, a dirty-white rock, with a few dark specks.

*Section*.—Ground-mass microgranulitic. Quartz and felspars with porphyritic quartzes, not very much corroded. Felspar forms filled up with felsitic matter and a radially-arranged mineral, highly coloured between crossed nicols. The quartzes carry inclusions with moving bubbles, often dihexahedral. Dirty greenish-black, semi-translucent grains are pretty evenly distributed over the section. They polarize feebly under the  $\frac{1}{4}$ -inch objective.

NOTE.—The following is an extract from the "Physiography of the Rock-making Minerals" (p. 292), explanatory of Rosenbusch's Formulae for Plagioclase Felspars, referred to in the foregoing notes (pp. 703 and 721).

"The chemical composition of the theoretical albite is  $\text{Na}_2\text{O}, \text{Al}_2\text{O}_3, 6 \text{SiO}_2 = \text{Na}_2, \text{Al}_2, \text{Si}_6, \text{O}_{16} = \text{Ab}$ ; that of anorthite,  $2 \text{CaO}, 2 \text{Al}_2\text{O}_3, 4 \text{SiO}_2 = \text{Ca}_2\text{Al}_2, \text{Al}_2, \text{Si}_4, \text{O}_{16} = \text{An}$ . All other lime-soda felspars, then, are isomorphous mixtures of albite and anorthite  $= \text{Ab}_x, \text{An}_y$ . Of the many possible mixtures, certain ones occur more frequently, and have received particular names. If these be enlarged by the addition of those compounds closely connected with them, then, following Tschermak, the lime-soda felspars or plagioclases may be brought into the following table:—

Albite series embraces the compounds	...	...	$\text{Ab}_1, \text{An}_0 - \text{Ab}_2, \text{An}_1.$
Oligoclase series	"	...	$\text{Ab}_2, \text{An}_1 - \text{Ab}_3, \text{An}_2.$
Andesine series	"	...	$\text{Ab}_3, \text{An}_2 - \text{Ab}_4, \text{An}_3.$
Labradorite series	"	...	$\text{Ab}_4, \text{An}_3 - \text{Ab}_5, \text{An}_4.$
Bytownite series	"	...	$\text{Ab}_5, \text{An}_4 - \text{Ab}_6, \text{An}_5.$
Anorthite series	"	...	$\text{Ab}_6, \text{An}_5 - \text{Ab}_0, \text{An}_1."$

### SUMMARY.

The foregoing notes throw no new light on the science of petrography. Indeed, one is struck with the microscopical similarity of the crystalline rocks of Australia, America, and Europe.

In many of the granites almost the same language can be used in describing the structure and constituting minerals of the innumerable varieties of the group as is employed by authorities like Rosenbusch, Rutley, Teall, Zirkel, and others.

This is no deterrent, however, to the student, because the very sameness of our crystalline rocks with those of other parts of the world proves the uniformity of those chemical and physical forces which operated so powerfully in their formation and subsequent mutations.

In all branches of science the recording of facts is the preliminary work. The arrangement and classification of these facts generally falls to the lot of a distinctly different type of worker. I have endeavoured to contribute something to the preliminary work.

The rocks described are divided into six groups, viz.:—Granites, Rhyolites, Basalts, Dolerites, Diorites, and Porphyrites. •

### GRANITES.

The *quartzes* of this group do not radically differ from those of the ordinary typical granites. Allusion may be made to the long, brilliant, colourless needles, particularly noticeable in the Croydon granite. They are not plentiful, possibly they are rutile, but might be apatite, though from their solitary habit I think the first more likely, as suggested by Teall in describing the Scotch granites. Many quartzes in this group carry such inclosures.

The *hornblendes*, both green and brown, are sometimes fringed with epidote. Occasionally a bluish-green envelope surrounds a deeper green or brown variety. It is

to be noted that epidote generally secretes itself on the felspar frontier rather than the quartz; that is to say, a hornblende bounded by quartz and felspar prefers to secrete the secondary mineral on the felspar boundary.

The *micas*, black and white, do not commonly exhibit that piercing with apatite which is frequent in the micas of typical German granites.

The *felspars* are, as a rule, exquisitely banded, and sometimes perfectly limpid. The fibrous structure in some of the felspars is to be noted, but not confounded with twinning.

Some of the orthoclases are very highly kaolinized, as is usual. Microcline intergrows with orthoclase, particularly in the Etheridge samples.

Undulose extinction is most marked in the Charters Towers granites; and with regard to this matter I may quote Teall's "British Petrography" (page 33):—"Zonal structure unquestionably indicates changes in the environment of the crystal during the period of growth. The separation of crystals in a magma must necessarily produce a change in the composition of the part which remains liquid; and this cause alone may explain such cases as those observed by Höpfner and Becke. Changes from green to brown and *vice versa* observed in certain hornblendes can probably be explained on the assumption that the growing crystals were alternately subjected to oxidising and reducing agencies. Until we are more fully informed as to the chemical and physical changes which occur during the period of crystal-building in igneous magmas, and the effects of such changes on the growing crystals, we cannot, however, hope to render a complete account of the various structures observed in the crystalline constituents of igneous rocks."

The accessory minerals are not so minutely described as is usual in this branch of science. I have not recognised any of the cubes, supposed to be salt cubes, in the quartz inclusions, neither have I noted any microscopic zircons, which are generally found in some samples of granite; but, as the prepared sections are to be handed over to the Geological Survey Department, it will be possible in the future for others to search more diligently, and with better instruments than are at my disposal.

*Apatite*, as an accessory mineral, nearly always is found in the vicinity of magnetite. Particularly is this so in the Charters Towers samples of granite.

The tourmaline granite of Cooktown is interesting from the fact that the Cornish tourmaline granite may be described in nearly the same language, and both are tin-bearing districts.

Teall says:—"The amount of tourmaline increases towards the margins of the granitic masses. The increase in the amount of tourmaline is accompanied by the disappearance of mica, and finally of felspar, the ultimate result being a rock composed of tourmaline and quartz (schorl rock)." But whether this holds in the Cooktown district is unknown to the Author.

The garnetiferous granite of the Cape River Gold Field bears out Zirkel's observation that the American garnet-bearing granites do not carry the mineral in microscopic size, all the garnets being macroscopic.\*

#### RHYOLITES.

These rocks exhibit fluxion-structure. Zirkel describes them as follows †:—"In the glassy and half-glassy rocks, it is a widely-spread phenomenon for the colourless green and black, needle-formed, microscopical elements to be grouped together into strings, bands, and flocks. There are bodies among them which have the appearance of

\* "Microscopical Petrography."

† *Loc. cit.*, p. 4.

undulated and bent streams, damming up before a larger crystal, and flowing around it to unite on the other side (giving the crystal something the appearance of an eye), often also really scattered and dissipated by one of them. These appearances evidently indicate that the fluctuations happened in the stiffening glass magma, after the microlites or little needle-formed crystals had been solidified. Analogous phenomena of motion, fluctuation or fluidal structure, invisible to the naked eye in the hand specimens, are very often observed in the thin sections of partly or almost wholly crystalline massive rocks, such as basalts, trachytes, phonolites, melaphyres, and greenstones. The smallest ledge-formed sections of orthoclastic or plagioclastic felspars, prisms of hornblende or augite, microlites of a variety of kinds; in short, all the microscopical bodies possessing a longitudinal axis, are locally grouped parallel to one another, and form undulating streams which diverge in the form of fans or ice-flowers. Where larger crystals lie in the paths of these crowded bands, the little needle-formed crystals encircle them on all sides with a tangential arrangement, are turned aside into different paths, or come to an abrupt end before them, as if by a shock, the microlites being thrown asunder in all directions. Observations of these phenomena of fluidal microstructure are best made between crossed nicols, for the single crystals are then coloured, and exhibit their characteristic direction much better than in ordinary light. A low magnifying power best enables one to overlook at once a larger portion of the thin section, and thereby to follow the lines of fluctuation. The shape of the little crystals is not without importance in the distinct observation of the form of the fluctuations. If they are needle-like or ledge-formed, even feeble movements of the mass will be unmistakably expressed; if, on the contrary, they are of a roundish, granular form, it often happens that strong fluctuations which have taken place fail to leave a trace of their action. In some rocks, especially the rhyolites, this wavy structure is produced by small dark grains grouped into lines and bands. These lines of grains undulate in a most remarkable manner, so that the figures of their curvature resemble marbled paper. There are also curled and twisted stripes of felsitic material, differing in colour and behaviour, which render the waving motion evident.

"Three important points present themselves upon which light is thrown by this remarkable microstructure, connected with the fluctuations of the solidifying mass. It proves that the rock was at one time a magma, in a plastic state, and that, after larger crystals had been secreted, a shifting and displacement of the small microlites happened. Soon afterward the mass seems to have been so suddenly solidified that the streams became fixed, and their fluctuation preserved for our observation. And, from these facts, the conclusion follows that the large and small crystals were not formed exactly where we perceive them, but that they have been thrown into their present place by the purely mechanical action of the surrounding plastic mass. It is worth mentioning that those rocks whose microfluidal structure is particularly distinct, are generally proportionately rich in broken crystals, shattered into detached, sharply angular fragments. And, lastly, this structure proves that the smallest crystals of the rock have not altered their mutual grouping and form, which date back to their solidification; and that, although secondary decompositions may have occurred in the lapse of time, these metamorphic influences have by no means been sufficient to obliterate the original characteristic structure."

The word "rhyolite" is compounded from *ῥύαξ* (a lava stream), and *λίθος* (a stone), and was first introduced by Richthofen in 1860.

I was somewhat exercised as to the inclusion of the quartz-trachytes of Mackay in the group, but Rutley says\*:—"Some petrologists include obsidian, pitchstone,

\* "The Study of Rocks," p. 177.

perlite, pumice, and certain quartziferous trachytic lavas, under the terms rhyolite and liparite. The student should therefore bear in mind the fact that the separation of the vitreous from the crystalline rocks refers merely to physical differences which the members of these two sub-classes respectively present, and does not imply any special difference in their chemical composition. These physical differences depend upon the conditions under which solidification was effected, whether gradual or rapid. In the former case the molten mass would develop crystals, in the latter it would remain amorphous; it would, in fact, result in a more or less perfect glass. In these natural glasses it is, however, common to find crystallites and crystals, the former usually developed very completely, the latter less perfectly formed as a rule, since they generally present rounded boundaries, or their angles, if any exist, also appear rounded."

From Rutley's remarks, as above quoted, and from the fact that the whole subject of the classification of rocks is so beset with pitfalls, it appeared safer to provisionally place the Mackay quartz-trachytes under the rhyolite group.\* Subsequently they may be re-classed, when the rock collections are more representative. I have no wish to evade the classificatory difficulty, but after quoting Professor Hutton's remarks on the difficulty of classifying rocks, I shall leave the reader to judge of the wisdom of waiting for further developments. He says †:—"The confusion, indeed, has become so great that some petrologists discard names as much as possible, and in their place give a list of the minerals composing the rock. This plan has the merit of not adding to our confusion, but it will not help us out of it. And when we read of 'plagioclase-augite-olivine-mica rock,' or of 'felspar-pyroxene-magnetite-garnet rock,' our patience is well-nigh exhausted.

"Natural science progresses by the comparison of objects, and when objects are numerous they must be named, if for no other purpose, still for indexing; so that an observer may readily find descriptions of similar objects for comparison, and ascertain what others have said about an object similar to the one he may be studying. As books get more and more numerous a uniform nomenclature becomes of more and more importance from the single point of view of indexing, and until some uniformity in rock nomenclature has been attained we cannot expect any very great advance in petrology."

The rhyolites are poorly represented in this Collection, but are generally typical. Particular attention is drawn to the Nell Isle sample, No. 108, which is so beautifully characteristic that the artist has drawn it in three different lights. For those readers to whom the subject is new they afford excellent illustrations of fluxion-structure and rock-texture.

The Mackay sample, No. 58, shown on Plate No. 62, fig. 2, is also a good type of the group.

The Mackay quartz-trachites are fairly interesting, but as type rocks they are not above the average. What makes them of special interest is that they illustrate Departmental work, having been prepared in London by a professional, and are about as thin as rock-sections can possibly be, which is *the* desideratum in petrography.

The Cloncurry obsidian calls for special notice, owing to its anisotropic properties. It faintly polarizes between crossed nicols, and it is remarkable that the section is free from microlites, crystal growths, and gas-pores. Zirkel says such volcanic glasses are extremely rare. Finally, the single example of tachylyte merits a

\* Mr. Maitland informs me that the Mackay trachites exhibit, in the field, almost all degrees of texture, from coarse trachites at one end of the series to nearly trachite glass at the other.

† "The Eruptive Rocks of New Zealand." A Paper read before the Royal Society of New South Wales, 7th August, 1889, and published in their journal, vol. xxiii., p. 102.



passing notice. Had circumstances been more kindly, the yellow glass would have teemed with crystals and crystallites. After reading Professor Judd's last Paper on "The Rejuvenescence of Crystals," one cannot help musing on the barrenness of a soil so capable of sustaining crystal life.

#### BASALTS.

But little description is necessary of this group of rocks, for the name is old and the rocks are familiar under that name to most. There are three varieties of basalts: basalts proper, anamesites, and dolerites; names denoting difference of structure or texture rather than mineralogical variation.

I. Basalt proper is compact, amorphous, often semi-vitreous, breaking with a perfectly conchoidal fracture.

II. Anamesite (from *ανά-μεσος*, intermediate) is uniformly crystalline, but close-grained, the crystals being very small.

III. Dolerite is coarsely crystalline, the word signifying deceitful, a name suggested by the difficulty of distinguishing it from certain Plutonic rocks.

Zirkel classifies the basalts mineralogically into—

1. Felspar-basalts.
2. Nepheline-basalts.
3. Leucite-basalts.

Mohl divides the members of the basalt group into—

1. Magma-basalts, with a colourless or brown-glass matrix.
2. Plagioclase-basalts, containing notably plagioclase and occasionally nephelene in addition to the essential augite, magnetite, &c. Leucite seldom.
3. Nepheline-basalts, containing notably nepheline, and sometimes leucite, in addition to augite, magnetite, &c. Plagioclase rare or absent.
4. Leucite-basalts.
5. Hauyne and nosean-basalts.
6. Mica-basalts.

Rutley says:—

"In microscopic sections of basalts which have undergone partial decomposition, the olivine and augite crystals are often merely represented by pseudomorphs of green matter, which is serpentine or some other hydrous silicate. The augite in basalts is generally rich in glass enclosures. Steam pores and fluid lacunæ are also of common occurrence in them. The olivine sometimes appears in tolerably well-defined crystals; but it is more usually in roundish grains, or in granular aggregates. The latter are sometimes of considerable size, and occasionally show, in external configuration, that they are large, rudely-developed crystals. The plagioclase basalts are of more frequent occurrence than any of the other rocks belonging to the basalt group."\*

The most interesting of the basalts, described in the foregoing pages, is the leucite-basalt from the Normanby Reefs of the Cooktown District. This is the first occurrence of leucite noted in Queensland. The Mineral Census of Australasia† (including only the Colonies of New South Wales, South Australia, Queensland, and New Zealand) records only three places where it has been recognised. They are—

1. Leucite-basalt, Castle Point, New Zealand.
2. Byrock, County Cowper, N.S.W. (T. W. E. David and W. Anderson.)
3. El Capitan, County Cambelego, N.S.W., in a basaltic lava sheet.

\* F. Rutley. The Study of Rocks, page 254.

† Report of Committee, No. 7; Mineral Census of Australasia. Proc. Austr. Assoc. Adv. Sci., II., 1890, pp. 213-273.

In connection with the subject of leucite rocks, Zirkel says:—

"More than twenty years ago, Alexander von Humboldt published his conclusion that leucite was a mineral only found in Europe; and it is rather curious that this casual remark has not been disproved until very recently. This mineral, up to the year 1868, was only known as a constituent of several lavas of Italy, of the Laacher See, and of the Kaiserstuhl, in Baden. Since that year, it has been discovered to be a microscopical ingredient of many basalts of Saxony, Bohemia, the Thüringer Wald, and the Rhön Mountains, occurring in unexpected frequency. But all these localities were European; so the remark still held good; and the other extra-European basic rocks, examined in large quantity, were never found to contain leucite.

"In 1874, Vogelsang discovered an Asiatic leucite. It occurred in a basaltic rock from the Gunung Bantal Soesoem, upon the small island of Bawean, north of Java.

"And now the microscopical study of the rocks of the Fortieth Parallel establishes the existence in America of the most classical leucite rocks. Moreover, these rocks are richer in the mineral than any occurrence in the Old World, besides which their general composition is very peculiar. Leucite was always considered, as is well known, one of the most perfect members of the regular system, until, in 1872, G. vom Rath stated that it belonged to the tetragonal or quadratic system, the apparent icositetrahedron being a combination of ( $P, P_2$ ). The colourless crystals, which generally show in the section a more or less regular or rounded octagon, have the peculiarity of containing a great quantity of strange little crystals and grains grouped into a small central heap or (which is more often the case) concentric zones, of which the sections are also octagonal or roundish. These corpuscula, which are supposed to be intruded into the leucite, are, instead, situated on the surface of the leucite forms or globular figures."\*

Teall states that leucite has not yet been found in Britain.†

The "Mitre Rock" sample from New Guinea is to be noted on account of the abnormally large size of the augites, many sections of which happen to be cut parallel to the plane of symmetry (010) or  $\infty P \infty$ . The other Queensland basalts of this collection call for no special remark, although some, like the Herberton basalts, are highly typical rocks. But the three samples from New South Wales (two from Bathurst, and the other from Mount Sassafrass) are, *par excellence*, the basalts of the whole collection. Some of Zirkel's excellent drawings in "Microscopical Petrography," quoted above, might almost be used to illustrate their textures.

The dolerites of the Sellheim River are so rich in apatite that one cannot fail to be struck with the sections, with their brilliant little water-clear hexagons appearing as black as ink, of course between crossed nicols.

Lastly, the Mount Kinchant (Mackay) sample is of interest, as it is pretty fresh, and its feldspars very much banded and pellucid.

#### DIORITES AND PORPHYRITES.

Diorite proper is a crystalline-granular mixture of plagioclase feldspars and hornblende, while porphyrite is characterised by a granular base of plagioclase feldspars, and either hornblende or augite, in which base are developed larger crystals of the same minerals. There is, therefore, a mineralogical connection between the two groups, though structurally they are different. Professor Hutton uses the word "porphyritic" for

\* "Microscopical Petrography," p. 259.

† "British Petrography." Note on Fig. 2, Plate xli.

describing a rock texture. Lyell uses the word in describing that granite in which large crystals of felspar, usually orthoclase, are sometimes scattered through an ordinary base of granite.

I have measured crystals in the porphyritic granite of Dartmoor two inches in length, and Lyell mentions crystals measuring three inches in length in the porphyritic granite of the Land's End.\*

The rocks are so variously named by different writers that it is not easy to be precise in definition. For instance, Judd, after examining some of my sections, states in a letter to me that "the rocks named 'Queensland granite'† belong to the class of quartz-diorites (tonalites) which appear to be very abundant in Queensland. They were recognised as such by the late Mr. R. Daintree."

The diorites are very poorly represented in the Collection. They call for no summarising.

In the rocks grouped under the head of porphyrites it is otherwise. The Croydon series is of interest, as are also the two, Nos. 79 and 80, from the Great Northern Tin Mine, Herberton. The sections from this porphyrite dyke show how much more the quartzes have suffered from erosion at the 300-foot level than is the case with the samples from the surface. No. 32, from the Peak, New South Wales, is remarkable for the size of the felspars. The artist had to draw this really striking section on a very much larger surface in order to illustrate the two sets of felspar twins (*Vide Plate 60*).

I should have liked to have learned something from the Gympie "greenstone" sections; but neither Mr. Rands nor myself came to any definite conclusions. In Mr. Jack's "Mineral Wealth of Queensland," published in 1888, he says:—"The greenstone of Gympie has long formed a subject of controversy . . . even in microscopic sections, these rocks are much altered and 'masked' by viridite."

## INDEX TO PLATES.

Plate 60.—Intrusive Dyke-stone from the Peak, New South Wales. C. S. Wilkinson's Collection. With polarizer only, magnified 50 diameters.

Plate 61, Fig. 1.—*Rhyolite*.—Nell Island, New Guinea. Sir W. Macgregor's Collection. With polarizer only, magnified 42 diameters.

„ Fig. 2.— „ Nell Island, New Guinea. Sir W. Macgregor's Collection. With parallel nicols, magnified 42 diameters.

Plate 62, Fig. 1.— „ Nell Island, New Guinea. Sir W. Macgregor's Collection. With crossed nicols, magnified 42 diameters.

„ Fig. 2.— „ Hamilton, Mackay, Queensland. A. G. Maitland's Collection. With crossed nicols, magnified 27·5 diameters, showing fluxion-structure.

Plate 63, Fig. 1.—*Tachylite*.—Queensland. R. L. Jack's Collection. With polarizer only, magnified 27·5 diameters.

„ Fig. 2.—*Quartz, with tourmaline crystals*.—With polarizer only, magnified 42 diameters. Cooktown. A. J. Madden, Esq., collector.

Plate 64, Fig. 1.—An interesting unnamed rock, from Cape Upstart, collected by R. L. Jack, partially prepared by him and finished by the Author. Mr. Jack has no more of the rock left, the whole chip having been ground away. Between crossed nicols, magnified 27·5 diameters.

\* Sir Charles Lyell. *Elements of Geology*, 2nd Edition, p. 556.

† The granites referred to are from Cooktown, John Bull, Ravenswood, and at about 700 feet down the Queen Block Extended shaft, Charters Towers.

- Plate 64, Fig. 2.—*Pitchstone*.—Sheffield, Tasmania. R. L. Jack's Collection. With polarizer only, magnified 42 diameters.
- Plate 65, Fig. 1.—*Basalt*.—Russell River, Queensland. R. L. Jack's Collection. With crossed nicols, magnified 50 diameters.
- „ Fig. 2.—*Augite crystal* showing twinning. Gympie, Queensland. W. H. Rands' Collection. With crossed nicols, magnified 50 diameters.\*
- Plate 66, Fig. 1.—*Obsidian*.—New Guinea. Sir W. Macgregor's Collection. With crossed nicols, magnified 50 diameters, showing fluxion-structure and quartz crystals full of gas pores.
- „ Fig. 2.—*Basalt*, Burdekin, Queensland. A. W. Clarke's Collection. With crossed nicols, magnified 27·5 diameters.
- Plate 67, Fig. 1.—Hornblende dyke running through the Durham Mine, Etheridge, Queensland. R. L. Jack's Collection. With polarizer only, magnified 27·5 diameters.
- „ Fig. 2.—Zeolitic mineral vein running rudely parallel to a calcspar vein in a red granite. Rainbow Claim, Charters Towers, Queensland. Natural size, drawn from a polished face.
- Plate 68.—Daunton's Hill, Upper Cape River, Queensland. W. H. Rands' Collection. Between crossed nicols, magnified 42 diameters. Mr. Rands states that quartz leaders running through this rock cease to carry payable gold. (No. 34 in Appendix.)

## NOTES TO PLATE 67, Fig. 2.

The Analysis of the red zeolite shown in this Plate is as follows :—

SiO <sub>2</sub>	...	...	...	...	...	...	...	47·0
H <sub>2</sub> O	...	...	...	...	...	...	...	13·7

This hydrated silicate is common on the Charters Towers Gold Field, occurring in the joints of the granite. Various samples have been analysed. The following are selected from many others :—

## 1. From the Queen Block Extended, 700 feet vertical.†

Silica	...	...	...	...	...	...	...	46·25
Alumina	...	...	...	...	...	...	...	27·35
Iron	...	...	...	...	...	...	...	Traces
Lime	...	...	...	...	...	...	...	13·95
Water (by ignition)	...	...	...	...	...	...	...	13·47
								101·02

## 2. From the Mary Claim, occurring at a depth of 300 feet.

SiO <sub>2</sub>	...	...	...	...	...	...	...	49·04
Al <sub>2</sub> O <sub>3</sub>	...	...	...	...	...	...	...	26·64
CaO	...	...	...	...	...	...	...	12·24
H <sub>2</sub> O (by ignition)	...	...	...	...	...	...	...	13·30
Fe <sub>2</sub> O <sub>3</sub>	...	...	...	...	...	...	...	Traces
								101·22

## 3. From the Mexican Claim, at a low depth.

SiO <sub>2</sub>	...	...	...	...	...	...	...	47·24
Al <sub>2</sub> O <sub>3</sub>	...	...	...	...	...	...	...	26·64
CaO	...	...	...	...	...	...	...	12·95
H <sub>2</sub> O	...	...	...	...	...	...	...	14·20
Fe <sub>2</sub> O <sub>3</sub>	...	...	...	...	...	...	...	Traces
								101·03

\* Mr. Rands has favoured me with the following description of this rock, which he names Diabase-porphyrite :—

“A dark-green, interbedded, amygdaloidal rock. Amorphous ground-mass, with porphyritic crystals sharply defined, and for the most part showing twinning. Magnetite in small grains, and calcite. Amygdules filled with carbonate of lime.”

† *Vide* Proc. R. Soc. Queensland, 1887.

## APPENDIX.

## A SHORT DESCRIPTION OF SOME OF THE CAPE RIVER ROCKS EXAMINED IN THIN SECTIONS UNDER THE MICROSCOPE. BY WILLIAM H. RANDB.

1. A dark-coloured, fine-grained *hornblende schist*, from Union Reef, near Mount Davenport. The slide consists almost entirely of green *hornblende* and quartz. The quartz contains enclosures of *apatite* and other minute enclosures. In a section cut transversely to the cleavage the longer axes of the hornblende have a linear arrangement.

2. A white *mica schist*, from Mount Davenport. The slide consists chiefly of quartz in small grains, with *mica*. In a section cut transversely to the cleavage of the rock the mica is arranged in layers.

3. A *hornblende schist*, from the southern slope of Mount Davenport. Green *hornblende*, beautifully cleaved, with bands consisting of grains of quartz. There is more hornblende than quartz in the section. *Magnetite* occurs in grains.

4. A red fine-grained *granite*, from Mount Frank. Quartz occupies the larger portion of the slide; it is full of minute enclosures. *Plagioclase felspar*, which is much kaolinized. White and black *mica*. The slide contains numerous large specks of *magnetite*.

7. *Felsite*, from dyke in schists, Pentland Reefs. The rock consists of a fine decomposed felspathic ground-mass, with *ferrite* throughout it.

8. A red, medium-grained *granite*, from Homestead Range. The section is rather thick and indistinct. The slide contains crystals of *plagioclase felspar*, and also beautiful star-shaped spherulites of *plagioclase felspar*; quartz, with enclosures of *magnetite*; *mica*; and specks of *magnetite* throughout the slide.

12. *Dolerite*, from dyke near Specimen Creek, Mount Remarkable. This slide is very thick, and the only minerals that can be determined are decomposed *felspar* and small specks of *augite* in a semi-crystalline ground-mass.

15. *Graphic granite*, from dyke near Specimen Creek, Mount Remarkable. The slide consists of elongated plates of quartz in *felspar*. All the quartz extinguishes simultaneously; and the same is the case with the *felspar*.

16. *Quartzite*, from Golden Hill, near Mount Remarkable. This rock consists almost entirely of semi-rounded and irregular-shaped granules of quartz, containing numerous enclosures, among which are small acicular crystals, probable *apatite*. There are crystals of *magnetite* in the slide, and some *ferrite*.

17. *Quartz felsite*, from a dyke on the ridge north of Mount Remarkable. The slide consists of an amorphous ground-mass, with blebs of quartz throughout it. It contains a little *ferrite*.

22. *Gabbro*, a dark crystalline rock from a dyke near Specimen Creek. This slide is made up of *diallage*, which is very feebly dichroic, a *plagioclase felspar*, and *mica*. Small grains of *magnetite* occur throughout it.

24. A white kaolinized *felsite*, from Running Creek, Norwood. It consists of an amorphous ground-mass, with minute grains of quartz throughout it, which have a banded structure. There are also small grains of *magnetite*, and a few porphyritic crystals of *felspar*.

25. A reddish-brown *felsite*, from Running Creek, Norwood. The slide shows a fine felspathic ground-mass, with minute lath-shaped crystals of *felspar* throughout it. Porphyritic crystals of *plagioclase felspar*, with enclosures of *apatite* and *magnetite*; a few porphyritic crystals of *orthoclase felspar*. Crystals of *magnetite* occur in the ground-mass. *Ferrite* occurs in considerable quantity, giving the red colour to the rock. The rock shows a beautiful perlitic structure.

26. A purplish *felsite* or *porphyry*, from Running Creek, Norwood. The rock consists of a dark-coloured amorphous ground-mass, containing a large amount of *ferrite*, and showing in parts a well-marked fluxion-structure. There are numerous porphyritic crystals of decomposed *felspar*, most of which were rubbed away in the preparation of the slide. Large crystals of *magnetite* occur.

27. *Dolerite*, from a dyke in Chinaman's Gully, Sandy Creek. A dark, fine-grained rock with a spherulitic structure on weathering. A felspathic ground-mass full of small

lath-shaped crystals of *felspar*, and also *magnetite* in both large and small grains. The pyroxene element has been changed into *viridite*. There are a few larger crystals of both *orthoclase* and *plagioclase felspar*.

30. *Hornblende schist*, from Sandy Creek. A very beautiful slide containing green *hornblende*, having a linear arrangement, and showing very perfect cleavage parallel to the plane of symmetry and faces of the prism. These crystals contain enclosures of *apatite* and *epidote*. Beautifully twinned crystals of *plagioclase felspar*, some of which appear to have had a secondary growth; they contain enclosures of *apatite*. A few solitary crystals of *orthoclase felspar*. There are a few specks of *quartz*; *magnetite* is very rare.

31. *Garnetiferous granite*, from the Pentland Range, at the head of Sandy Creek. The slide is much broken. The minerals that can be distinguished are—*Quartz*, containing prismatic enclosures of *apatite*; *plagioclase felspar*; *mica*, and *garnets*.

33. *Hypersthene rock*. A dark-coloured, highly crystallised rock, from a dyke on Dauntou's Hill, Upper Cape. *Hypersthene* is the principal mineral. It is a green mineral, possessing strong pleochroism; the cleavage is prismatic. The mineral extinguishes parallel to the planes of cleavage. It contains several hexagonal enclosures of *apatite*, and also of *quartz*; streaks of *quartz* follow the cleavage planes. It also contains enclosures of *magnetite*. *Quartz* in large plates is the next mineral in importance; it is full of very minute enclosures. *Brown mica* occurs in the hypersthene, and also in a semi-transparent iron compound—*leucorene*, of which mineral there is a large amount in the slice.

34. *Hornblende schist*, from Dauntou's Hill, Upper Cape. A crystalline rock resembling a coarse diorite, except that the hornblende occurs more or less in layers. This is the rock in contact with which the leaders on Dauntou's Hill ceased to carry gold. The rock is made up to a large extent of very beautifully twinned crystals of *oligoclase felspar*, full of small hexagonal enclosures of *apatite*, and also enclosures of *leucorene*. *Hornblende*, well-cleaved, and containing also enclosures of *apatite*. *Quartz* in small blebs. *Magnetite* changing around its edges into *leucorene*.

35. *A highly crystalline schist*, from Mount Elvan, Upper Cape. *Quartz* is the principal mineral; it contains enclosures of small *garnets*. Entwined around the quartz is green *hornblende*. *Plagioclase felspar*. Very small *garnets* occur throughout the rock.

36. A fine-grained, grey micaceous granite, from Mount Elvan, Upper Cape. The minerals in the slide are—*Plagioclase felspar*, some of which is much decomposed. Well-cleaved *white mica*; and *quartz* with acicular crystals of *apatite*, and other minute enclosures.

38. *A purplish porphyry*, from the Cape River, near the Pot-hole Lead, Upper Cape. It consists of an amorphous ground-mass, showing fluxion-structure, and full of *ferrite* and *magnetite*. It contains porphyritic crystals of *plagioclase felspar*.

40. *Olivine basalt*, from Mount Black. A compact black rock, possessing polarity. The slide shows a microcrystalline ground-mass, containing numerous specks of *magnetite*, with crystals of *olivine*, a few crystals of *felspar*, and specks of *augite*.

42. *Olivine basalt*, from the Tableland, Oxley Creek, a somewhat scoriaceous basalt containing zeolites. The rock consists of an interlaced mass of acicular crystals of *felspar*, with crystals of *olivine* throughout it. Some of the olivine crystals are much decomposed around their margins, and along cracks in the crystals. *Magnetite* is comparatively rare.

43. *Basalt*, from the Basaltic Wall, Lolworth. A highly scoriaceous basalt. The rock was a difficult one to cut, and the slice is very small. It shows an interlaced mass of crystals of *plagioclase felspar*, with small specks of *olivine*.

NOTE.—The microscopical slides described above were prepared for me by Mr. A. W. Clarke.

## APPENDICES.

### APPENDIX I.

#### AGE OF THE MOUNT ALBION AND CHILLAGOE BEDS.

My Colleague leans to the opinion (*See* pp. 118-120) that these beds are equivalent to those of the Palmer and Hodgkinson, which he provisionally refers to the Gympie Series, but remarks on the paucity of organic remains. Mr. William Thompson, Government Mineralogical Lecturer, appears to have been more fortunate in the discovery of fossils, and says\*:

"Owing to the alteration the limestone has undergone the fossil remains are generally so crystalline that beyond the outline nothing indicative of the original organic structure remains. Corals and encrinite stems are everywhere common, though, as a rule, very imperfect; in places, however, bands of rock exist containing remains more or less distinct, and from these several fossils have been derived. Amongst them are examples of *Aviculopecten* and *Euomphalus*, *Cyathocrinus*, *Lithostrotion basaltiforme*, *Zaphrentis*, *Cyathophyllum*, and numerous other corals. Two or three poor specimens of what appear to be small Trilobites and a fine example of an Annelid were also found. I would remark that these are named with reserve; as I have no means of comparing them either with recognised specimens or diagrams."

The assemblage of fossils named by Mr. Thompson *might* be present in a Carboniferous deposit, but I have never seen *Lithostrotion basaltiforme* in Australia, nor have I seen *Cyathophyllum* in the Queensland Permo-Carboniferous. *Zaphrentis*, however, does occur in the latter, as well as close allies of *Cyathocrinus*. Allowing for Mr. Thompson's "reserve" in naming the fossils as he had done—a reserve which would be justifiable on the part of any Palæontologist without "means of comparing them either with recognised specimens or diagrams"—the supposition of the Permo-Carboniferous age of the beds in question appears still to be the most probable.

E.

### APPENDIX II.

#### THE GLASSHOUSE MOUNTAINS.

The difficulty of determining the nature of the rock composing these mountains is considerably increased by the conflicting testimony of various writers on the subject. Mr. Stutchbury, in 1854, regarded the rock as a "metamorphic sandstone" (*See* page 73). The Honourable A. C. Gregory (*See* page 5) referred to it, in 1879, as an "outburst of porphyry." Finally, the Rev. J. E. Tenison Woods, in 1888, in his Paper on the Desert Sandstone,† published a view of "Prismatic Basalt, Glasshouse Mountains," but without any reference in the text.

Recently Mr. Henry G. Stokes has presented to the Geological Survey a series of specimens collected in the Mountains themselves, from which it appears that the staple rock is trachite, although it is possible that basalt or porphyries may be present as intrusive masses. The mountains are accordingly marked in the Geological Map as trachite.

J.

### APPENDIX III.

#### ARTESIAN WELLS.

Referring to the remarks on page 418, regarding the possible diminution of the supply from Artesian Wells, the Charleville Well furnishes some suggestive facts.

In 1890 the pressure per square inch had increased from 95 lb. to 100 lb., and the temperature was 106° Fahr.‡ On 10th July, 1892, the pressure had decreased to 87 lb., and the temperature to 101°. The last-mentioned measurements were made by Mr. J. B. Henderson, Hydraulic Engineer, in my presence.

J.

\* In Annual Report of the Department of Mines for 1891, p. 135. Brisbane: by Authority: 1892.

† Proc. Roy. Soc. N. S. Wales.

‡ See page 427.

## APPENDIX IV.

## ORGANIC REMAINS, EIGHT-MILE PLAINS, NEAR BRISBANE.

In stating (p. 608) that remains of the Extinct Mammalia had been discovered in this locality, I was under the impression that Mr. C. W. De Vis had obtained, among others, remains of an extinct Species of Wombat, but Mr. De Vis informs me that I was mistaken. The only organic remains from the Eight-Mile Plains yet identified are those of *Ceratodus Fosteri* and *Pallimnarchus pollens*—a fish and a reptile, both of living species. The case, then, still stands thus, that the known remains of extinct mammalia have all been derived from comparatively high levels, whatever significance the fact may have.

J.

## APPENDIX V.

## EOCENE BEDS IN VICTORIA.

The following should have been added as a footnote after the word "Miocene," p. 575, line 29:—

"Professor R. Tate, on the other hand, regards the fossils from the Schnapper Point clays, Port Phillip, as of Eocene age. *Journ. R. Soc. N. S. Wales* for 1888 [1889], xvii., p. 242."

J.

## APPENDIX VI.

## DARR RIVER DOWNS BORE No. 3.

In a paragraph on p. 424, the depth of this bore is given as 2,700 feet, and the daily overflow as 50,000 gallons. The bore has since been continued to 3,530 feet, and is therefore the deepest in the Australian Colonies. (See "Muckadilla Bore," p. 428.) Mr. Fiskin, one of the owners of the Station, states that the "bottom" is sandstone, that the daily overflow is 500,000 gallons, and that the temperature of the water is 172° Fahr.

J.

## APPENDIX VII.

## LACERTILIAN REMAINS ON SUTTOR RIVER.

An additional locality for remains of the extinct Lacertilia has been furnished by Mr. De Vis, who informs me that a Vertebra of *Megalania*, from black soil on the bank of a lagoon at Mount Lookout, near the head of the Suttor River, was sent to him by Mr. Peter Murray about twelve years ago, and is now in the Queensland Museum.

J.

## APPENDIX VIII.

## LIST OF FOSSILS OF THE BURRUM BEDS, WITH THEIR SYSTEMATIC POSITIONS.

In consequence of the introduction of *Phyllopteris Feistmanteli* into my Colleague's List after Chapter XXIII. was in type, the following corrections are necessary:—

Page 311. After the paragraph on *Teniopteris (Angiopteridium) Daintreei*, insert:—

"Genus—*PHYLLOTHECA*, Saporta.

"*PHYLLOPTERIS FEISTMANTELI*, Eth. fil.

"Loc. Styx Coal Field (Burrum Beds). Occurs also at Stewart's Creek, Rockhampton —(Ipswich Beds)."

Page 312. In the Synopsis, after *Alethopteris australis*, Morr., insert:—

"\* *Phyllopteris Feistmanteli*, Eth. fil."

And the last two lines should read:—

"Of the thirteen species above named, five are common to the Ipswich Formation, and the remaining eight are peculiar to the Burrum Formation."

J.



## APPENDIX IX.

## DESCRIPTIONS OF THE SPECIES OCCURRING IN THE BURRUM FORMATION.

In consequence of the introduction of the new species *Phyllopteris Feistmanteli* after Chapter XXIV. was in type, the following addition becomes necessary:—

Page 315. After the paragraph on the Genus *Trichomanites*, insert:—

“Genus—*PHYLLOPTERIS*, *Saporta*, 18—.

“*PHYLLOPTERIS* *FEISTMANTELI*, *Eth. fil.*

“*Obs.* For description of the species, see ‘Ipswich Beds’ (p. 375).

“*Loc.* Styx Coal Field (Burrum Beds). Occurs also at Stewart’s Creek, Rockhampton —(Ipswich Beds).”

**E.**

## APPENDIX X.

## GEM-BEARING DRIFT AT WITHERSFIELD.

For an account of a Drift, probably of Tertiary age, containing Sapphires, Oriental Emeralds, Zircons, &c., see Report by the Writer “On Sapphire Deposits and Gold and Silver Mines near Withersfield.” Brisbane: by Authority: 1892.

**J.**



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